CITY OF MORRO BAY

WATER RECLAMATION FACILITY

TABLE OF CONTENTS

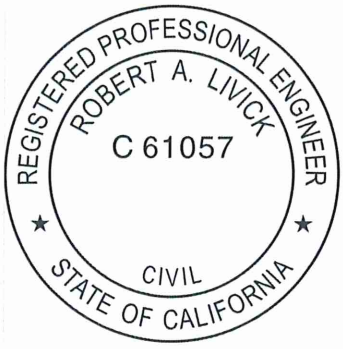
ISSUED FOR CONSTRUCTION

MAY 2020

APPROVED FOR CONSTRUCTION
IFC Effective Date: 20 May 2021

11 January 2021

Rob Livick, PE/PLS - City Engineer
City of Morro Bay



JOINT VENTURE

FILANC BLACK & VEATCH

The specifications prepared by the following registered engineer are listed in the Table of Contents as indicated by their initials.

Engineering Manager
Erick Bevington, P.E.
Black & Veatch Corporation

5/20/2020

The specifications prepared by the following registered engineer are listed in the Table of Contents as indicated by their initials.

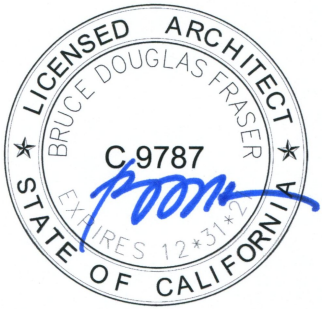
Project Engineer
Kaitie Zusy, P.E.
Black & Veatch Corporation

5/19/2020

The specifications prepared by the following registered engineer are listed in the Table of Contents as indicated by their initials.

Structural Engineer
Charles R. Ashley, Jr., S.E.
Ashley and Vance Engineering, Inc.

The specifications prepared by the following licensed architect are listed in the Table of Contents as indicated by their initials.



Architect
Bruce Fraser, AIA
Frasier Seiple Architects

The specifications prepared by the following registered engineer are listed in the Table of Contents as indicated by their initials.

2020.05.22 13:57:07-05'00'

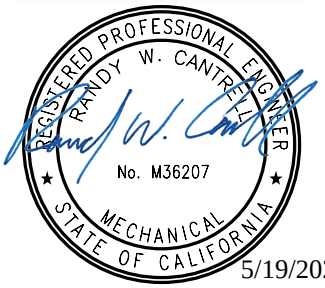
Electrical Engineer
Mark Kleveter, P.E.
Black & Veatch Corporation

The specifications prepared by the following registered engineer are listed in the Table of Contents as indicated by their initials.

Instrumentation & Control Engineer
Brian L. Butler, P.E.
Black & Veatch Corporation

5/19/2020

The specifications prepared by the following registered engineer are listed in the Table of Contents as indicated by their initials.



Building Mechanical Engineer
Randy W. Cantrell, P.E.
Black & Veatch Corporation

5/19/2020

Number	Title	Author
DIVISION 1 – GENERAL REQUIREMENTS		
01 33 00	Submittals Procedures	EVB
01 45 33.3	Code Required Special Inspections and Procedures (IBC 2015)	CRA
01 61 00	General Equipment Stipulations	EVB
01 67 00.2	Meteorological and Seismic Design Criteria (IBC 2012 & 2015)	CRA
01 68 00	Equipment and Valve Identification	EVB
01 73 19	Equipment Installation	EVB
01 75 11	Startup Requirements (Deferred Submittal)	
01 79 00	Demonstration and Training	EVB
01 91 00	Commissioning (Deferred Submittal)	
DIVISION 2 – Not Used		
DIVISION 3 – CONCRETE		
03 01 26.66	Concrete Crack Repair	CRA
03 08 13	Tightness Testing of Structures	EVB
03 08 13.S01	Tightness Testing of Structures - Schedule	EVB
03 11 00	Concrete Forming	CRA
03 15 19	Concrete Joints and Accessories	CRA
03 20 00	Concrete Reinforcing	CRA
03 30 00	Cast-in-Place Concrete	CRA
03 30 13	Concrete Placing	CRA
03 35 00	Concrete Finishing	CRA
03 39 00	Concrete Curing	CRA
03 60 00	Grouting	CRA
DIVISION 4 – MASONRY		
04 00 00	Masonry	BDF, CRA

Number	Title	Author
DIVISION 5 – METALS		
05 40 00	Cold-Formed Metal Framing	BDF, CRA
05 50 00	Metal Fabrications	BDF, CRA
05 50 13	Structural Metals	CRA
05 52 13	Metal Railings	CRA
05 53 13	Metal Gratings	CRA
05 81 00	Anchorage In Concrete and Masonry	CRA
DIVISION 6 – WOOD, PLASTICS, AND COMPOSITES		
06 41 00	Casework	BDF
06 74 15	Fiberglass Reinforced Railings	EVB
DIVISION 7 – THERMAL AND MOISTURE PROTECTION		
07 05 00	Membrane Roofing	BDF
07 11 00	Dampproofing	EVB
07 20 00	Building Insulation	BDF
07 60 00	Flashing and Sheet Metal	BDF
07 92 00	Joint Sealants	BDF
DIVISION 8 – OPENINGS		
08 10 00	Metal Doors and Frames	BDF
08 15 40	Fiberglass Doors and Frames	BDF
08 33 00	Overhead Coiling Doors	BDF
08 40 00	Storefront Systems	BDF
08 51 13	Metal Windows	BDF
08 62 50	Ducted Skylights	BDF
08 70 00	Door Hardware	BDF
08 80 00	Glass and Glazing	BDF
08 90 00	Louvers and Vents	RWC

Number	Title	Author
DIVISION 9 – FINISHES		
09 25 00	Gypsum Drywall	BDF
09 30 00	Ceramic Tile	BDF
09 51 20	Suspended Acoustic Tile Ceiling	BDF
09 90 00	Paints and Coatings	BDF
09 96 11	Protective Coatings	EVB
09 97 24	Corrosion Protection Systems	EVB
DIVISION 10 – SPECIALTIES		
10 12 16	Toilet Partitions	BDF
10 28 00	Bathroom Accessories	BDF
10 40 00	Signage	BDF
10 44 00	Fire Extinguishers and Cabinets	BDF
DIVISION 11 —– Not Used		
DIVISION 12 —– Not Used		
DIVISION 13 – SPECIAL CONSTRUCTION		
13 34 19	Metal Building Systems	BDF
13 47 13	*Cathodic Protection System – See IFC Yard Piping Specifications*	
DIVISION 14 – Not Used		
DIVISIONS 15 THROUGH 20 – Not Used		
DIVISION 21 – FIRE SUPPRESSION		
21 13 00	Fire-Suppression Sprinkler Systems	RWC
DIVISION 22 – PLUMBING		
22 00 00	Plumbing	RWC
22 05 11	Mechanical Building Systems Materials and Methods	RWC

Number	Title	Author
22 11 19	Backflow Preventers	RWC
22 11 26	Water Meters	RWC
22 13 17	Cast Iron Soil Pipe and Accessories	RWC

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING

23 00 00	Heating, Ventilating, and Air Conditioning	RWC
23 05 93	Testing, Adjusting, and Balancing for HVAC	RWC
23 09 11	Building Systems Controls	RWC
23 50 11	Heating System Equipment	RWC
23 70 00	Refrigeration Systems	RWC

DIVISION 24 – Not Used

DIVISION 25 – INTEGRATED AUTOMATION – Not Used

DIVISION 26 – ELECTRICAL

26 05 11	Electrical	MK
26 05 83	Electrical Equipment Installation	MK
26 24 13	Switchboards	MK
26 24 23	600 Volt Class Motor Control Centers	MK
26 29 24	Variable Frequency Drives	MK
26 32 13	Engine-Generator	EVB
26 36 26	Bypass-Isolation Automatic Transfer Switch	MK
26 41 13	Lightning Protection for Structures	MK
26 50 01	Performance Lighting	MK

DIVISION 27 – Not Used

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 10 01	Facility Security System	MK
28 31 16	Fire Detection and Alarm Systems	MK

Number	Title	Author
DIVISIONS 29 THROUGH 30 – Not Used		
DIVISION 31 – EARTHWORK		
31 23 11	*Excavation and Fill for Structures – See IFC Yard Piping Specifications*	
31 23 33	*Trenching and Backfilling – See IFC Yard Piping Specifications*	
DIVISION 32 – EXTERIOR IMPROVEMENTS		
DIVISION 33 – UTILITIES		
33 05 14	Manhole and Vault Covers and Accessories	EVB
33 13 13	Cleaning and Disinfection of Water Pipelines	EVB
33 14 00	*Pipeline Pressure and Leakage Testing – See IFC Yard Piping Specifications*	
33 16 13.13	Steel Water Storage Reservoir	EVB
33 31 33	*Sewer Pipe Installation and Testing – See IFC Yard Piping Specifications*	
DIVISION 34 – TRANSPORTATION – Not Used		
DIVISION 35 – WATERWAY AND MARINE CONSTRUCTION – Not Used		
DIVISIONS 36 THROUGH 39 – Not Used		
DIVISION 40 – PROCESS INTEGRATION		
40 05 05.11	*Miscellaneous Piping and Accessories Installation – See IFC Yard Piping Specifications*	
40 05 17	*Copper Tubing and Accessories – See IFC Yard Piping Specifications*	
40 05 19	*Ductile Iron Pipe – See IFC Yard Piping Specifications*	
40 05 19-S01	*Ductile Iron Pipe Schedule – See IFC Yard Piping Specifications*	
40 05 23	Stainless Steel Pipe and Alloy Pipe, Tubing, and Accessories	KEZ
40 05 23-S01	Stainless Steel Pipe and Alloy Pipe, Tubing, and Accessories Schedule	EVB

Number	Title	Author
40 05 24	*Steel Pipe – See IFC Yard Piping Specifications*	
40 05 24 – S01	*Steel Pipe Schedule Buried – See IFC Yard Piping Specifications*	
40 05 24 – S02	Steel Pipe Schedule Above Grade	EVB
40 05 24.43	Miscellaneous Steel Pipe, Tubing, and Accessories	EVB
40 05 31.12	*Polyvinyl Chloride (PVC) Pressure Pipe – See IFC Yard Piping Specifications*	
40 05 31.16	*Polyvinyl Chloride (PVC) Sewer Pipe – See IFC Yard Piping Specifications*	
40 05 32	*Miscellaneous Plastic Pipe, Tubing, and Accessories – See IFC Yard Piping Specifications*	
40 05 32 – S01	*Miscellaneous Plastic Pipe, Tubing, and Accessories Schedule Buried – See IFC Yard Piping Specifications*	
40 05 32 – S02	Miscellaneous Plastic Pipe, Tubing, and Accessories Schedule Above Grade	EVB
40 05 33.11	*High Density Polyethylene (HDPE) Pressure Pipe – See IFC Yard Piping Specifications*	
40 05 33.11 – S01	*High Density Polyethylene (HDPE) Pressure Pipe Schedule – See IFC Yard Piping Specifications*	
40 05 41	*Miscellaneous Piping and Pipe Accessories – See IFC Yard Piping Specifications*	
40 05 51.13	Valve Installation	EVB
40 05 51.16	Gate Installation	EVB
40 05 56	*Miscellaneous Valves – See IFC Yard Piping Specifications*	
40 05 57	Valve and Gate Actuators	EVB
40 05 59.13	Open-Channel Metal Slide Gates and Weir Gates	EVB
40 05 59.13-S01	Open-Channel Metal Slide Gates and Weir Gates Schedule	EVB
40 05 61.23	Resilient-Seated Gate Valves	RWC
40 05 61.43	Knife Gate Valves	EVB
40 05 61.43-S01	Knife Gate Valves Schedule	EVB
40 05 62.16	Eccentric Plug Valves	EVB
40 05 62.16-S01, S02, S04	Eccentric Plug Valves Schedules	EVB
40 05 63.53	Miscellaneous Ball Valves	EVB
40 05 64.22	Industrial Butterfly Valves	EVB
40 05 64.22-S01, S02, S03	Industrial Butterfly Valves Schedules	EVB

Number	Title	Author
40 05 67	Globe Valves	EVB
40 05 68	Check Valves	EVB
40 05 68-S01	Check Valves Schedule	EVB
40 05 73.13	Pressure Reducing Valves	RWC
40 05 84.11	Pinch and Diaphragm Valves	EVB
40 05 86	Air Valves	EVB
40 05 86-S01	Air Valves Schedule	EVB
40 05 88.11	Solenoid Valves	EVB
40 05 93	Common Motor Requirements for Process Equipment	MK
40 06 20	*Schedules for Liquids Process Piping – See IFC Yard Piping Specifications*	
40 42 11	Mechanical Insulation	EVB
40 61 11	Instrumentation and Control System	BLB
40 61 11A	Instrument Devices	BLB
40 62 00	Computer System Hardware	BLB
40 64 00	Programmable Logic Controllers	BLB
40 64 00A	Input/Output List	BLB
40 64 01	Vendor Standard Programmable Logic Controllers	BLB
40 66 11	Network Systems	BLB
40 66 33	Metallic and Fiber Optic Communication Cable and Connectors	BLB
40 67 11	Panels, Consoles, and Appurtenances	BLB
40 68 16	Computer System Software	BLB
40 68 83	Software Control Block Descriptions	BLB
40 69 13	Uninterruptible Power Supply	BLB
40 71 00	Flow Instruments	BLB
40 72 00	Pressure and Level Instruments	EVB
40 73 12	Pressure Gauges	EVB
40 73 12-S01	Pressure Gauges Schedule	EVB
40 74 00	Temperature Instruments	BLB
40 75 00	Process Analytical Instruments	BLB
40 78 00	Panel Mounted Instruments	BLB
40 79 11	Miscellaneous Instruments	BLB

Number	Title	Author
DIVISION 41 – MATERIAL PROCESSING AND HANDLING EQUIPMENT		
41 12 13.36	Screw Conveyors – See procurement package	
41 12 13.36	Screw Conveyors - Dewatering	KEZ
DIVISION 42 – PROCESS HEATING, COOLING, AND DRYING EQUIPMENT – Not Used		
DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT		
43 05 21	Seal Water Stations	EVB
43 05 41	Chemical Storage Tank Installation	EVB
43 11 15	Dry Screw Positive Displacement Blowers	KEZ
43 11 17	Rotary Lobe Positive Displacement Blower	KEZ
43 11 17 - MBR	Rotary Positive Displacement Blower – MBR – See procurement package	
43 23 13.14	Horizontal End Suction Centrifugal Pumps - IPR	EVB
43 23 13.14 - Outfall Pumps	Horizontal End Suction Centrifugal Pumps - Outfall Pumps	EVB
43 23 13.14 - SAFE Filter	Horizontal End Suction Centrifugal Pumps - SAFE Filter	KEZ
43 23 13.14 - MBR	Horizontal End Suction Centrifugal Pumps – MBR – See procurement package	
43 23 58	Rotary Lobe Pumps	KEZ
43 23 58 - MBR	Rotary Lobe Pumps – MBR – See procurement package	
43 24 13	Vertical Multistage Centrifugal Pumps – See procurement package	
43 25 14	Sanitary Lift Station	EVB
43 25 15	Water Pressure Booster Systems	KEZ
43 25 60	Submersible Horizontal Propeller Pumps	KEZ
43 40 40	Liquid Chemical Feed Systems	EVB
43 40 41	Polymer Feed Systems	EVB
43 41 45.13	Fiberglass Reinforced Plastic Storage Tanks	EVB
43 41 45.13-DS01 – DS05	Fiberglass Reinforced Plastic Storage Tanks-Data Sheet	EVB

Number	Title	Author
DIVISION 44 – POLLUTION AND WASTE CONTROL EQUIPMENT		
44 31 31	Odor Control Biofilter	EVB
DIVISION 45 – INDUSTRY-SPECIFIC MANUFACTURING EQUIPMENT – Not Used		
DIVISION 46 – WATER AND WASTEWATER EQUIPMENT		
46 11 35	MBR Equipment – See procurement package	
46 21 10	Packaged Headworks System – See procurement package	
46 21 12	Mechanically Cleaned Bar Screens – See procurement package	
46 22 00	Packaged Fine Screens	EVB
46 23 23	Vortex Grit Removal Equipment – See procurement package	
46 23 64	Grit Separation and Classification Equipment – See procurement package	
46 41 23	Submersible Mixers	KEZ
46 42 24	In-Line Static Mixers	EVB
46 51 21	Coarse Bubble Diffusers	KEZ
46 51 31	Fine Pore Diffused Aeration Equipment	KEZ
46 61 35	MBR – See procurement package	
46 61 41	Disk Cloth Filters	KEZ
46 63 26	Low Pressure Reverse Osmosis System – See procurement package	
46 63 26	Low Pressure Reverse Osmosis System - Data Sheet – See procurement package	
46 66 56.17	Closed Channel UV – See procurement package	
46 76 21	Belt Filter Presses	KEZ
46 76 22	Calcite Contactor	EVB
DIVISION 47 – Not Used		
DIVISION 48 – ELECTRICAL POWER GENERATION – Not Used		

Number	Title	Author

Notes:

1. The *italicized* specifications have been issued with the IFC Yard Piping set.
2. The red specifications have been purchased and procured. See separate procurement packages and forthcoming shop drawings.

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Section 01 33 00

SUBMITTAL PROCEDURES

1. SHOP DRAWINGS AND ENGINEERING DATA.

1.01. General.

This section stipulates the requirements for engineering data that the Supplier shall submit for design information and review. The document submittal procedures shall be in accordance with the requirements of this Specification.

Shop Drawings and engineering data (submittals) covering all equipment and all fabricated components and building materials which will become a permanent part of the Work under this Contract shall be submitted to Design-Builder for review. Submittals shall verify compliance with the Contract Documents, and shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and the operation of component materials and devices; the external connections, anchorages, and supports required; the performance characteristics; and dimensions needed for installation and correlation with other materials and equipment as required by the Design-Builder.

All submittals, regardless of origin, shall be approved by Design-Builder and clearly identified with the name of this Contract, and references to the applicable specification paragraphs and Contract Drawings. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data. The Owner will only review submittals based upon the agreed upon list between the Owner and the Design-Builder.

All deviations from the requirements of the Contract Documents shall be identified as deviations on each submittal and shall be noted by the Suppliers by red-lining a copy of the Specification and/or the Drawings. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by the Supplier (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

Technical data submittals shall be submitted in electronic format.

Electronic technical data submittals shall be made using the Procore project collaboration system, a Web-based file transfer handling service. If Supplier does not already have Procore transmittal capability, the Design-Builder will provide the required credentials for access upon Purchase Order award.

1.02. Compliance Reports. Reports shall be submitted that record the tests and/or calculations required in the specification technical sections. Reports shall be submitted for each piece of equipment or each plant system.

1.03. Motor and Electric Actuator Information. If required by the Specifications, Motor and Electric Actuator Information shall be submitted in accordance with the Common Motor Requirements for Process Equipment section.

1.04. Drawings. Drawings shall be of sufficient detail to indicate the kind, size, arrangement, component weight, breakdown for shipment, and operation of component materials and devices; the external connections, anchorages, supports, and grouting requirement; the dimensions needed for installation and correlation with other materials and equipment; and the information specifically requested in both Section 2 of this Specification and the Schedule of Submittals section.

Drawings for use in installation and erection shall include a Bill of Quantity (BOQ), identifying the unit of measure, quantity, description, part number (or piece mark identifier), location reference on the drawing and any other details required by Design-Builder. It may be acceptable to have the BOQ detail in other means or media, if approved in advance by Design-Builder.

Supplier shall fully complete, check, and certify drawings, including drawings produced by a subcontractor, for compliance with the Purchase Order requirements prior to submittal. Drawings shall have title block entries that clearly indicate the drawing is certified.

Each submitted drawing shall be project unique and shall be clearly marked with the name of the project, unit designation, Design Builder's Purchase Order title, Design Builder's Purchase Order file number, project equipment or structure nomenclature, component identification numbers, and Design Builder's name. Equipment, instrumentation, and other components requiring Design-Builder-assigned identification tag numbers shall be clearly identified on the drawings. If standard drawings are submitted, the applicable equipment and devices furnished for the project shall be clearly marked.

Transmittal letters shall be included with each submittal. It shall clearly identify the specification section reference and any contract drawing reference. It shall summarize the components of the submittal and list any attachments.

Catalog pages are not acceptable, except as drawings for standard nonengineered products and when the catalog pages provide all dimensional data, all external termination data, and mounting data. The catalog page shall be submitted with a typed cover page clearly indicating the name of the project, unit designation, specification title, specification number, component identification

numbers, model number, Supplier's drawing number, and Design Builder's name.

Drawings shall be submitted with all numerical values in English units.

All multi sheet documents shall be submitted in their entirety for all revisions.

1.04.01. Drawing Submittal. Drawings shall be submitted electronically in Portable Document Format (PDF). AutoCAD or MicroStation format files are not acceptable. If Supplier does not have the capability to provide Portable Document Format (PDF), an alternative submittal format shall be used as mutually agreed between Design-Builder and Supplier.

1.04.02. Drawing Processing. Supplier's engineering schedule shall allow a minimum of three (3) weeks for transmittal, processing, and review of drawings and data by Design-Builder.

Unless this Purchase Order indicates that a drawing or engineering data submittal by Supplier is to be for Design-Builder's information only, Design-Builder, upon receipt of submittals, shall review and return same to Supplier, marked "No Exceptions Noted," "Exceptions Noted," "Received for Distribution," "Returned for Corrections," "Release for Record," "Void," "Superseded" or "Hold" The timing of Supplier's submittals and Purchaser's review shall be in accordance with the Completion Dates for same as set forth in the Purchase Order or the project schedule. The submittal of any drawing or other submittal document by Supplier to Design-Builder under this Purchase Order will be certified by Supplier that the information set forth therein is accurate in all material respects.

1.04.02.01. No Exceptions Noted (NE) or Received for Distribution (RD). Upon receipt of a submittal marked "No Exceptions Noted" or "Received for Distribution," Supplier may proceed with its Work to the extent of and in accordance with the submittal. Supplier shall not resubmit unless the drawing or document is revised, in which case it shall be resubmitted as a new document revision in accordance with the Resubmittals section.

1.04.02.02. Exceptions Noted (EN). Upon receipt of a submittal marked "Exceptions Noted" and if Supplier concurs with Design-Builder's comments, Supplier shall incorporate same and may proceed with its Work to the extent of and in accordance with the annotated submittal. Supplier shall submit to Design-Builder within fourteen calendar days a revision to the original submittal in which Design-Builder's comments, unless the individual comment indicates it does not require a resubmittal or revision, have been incorporated. If Supplier determines that it cannot incorporate Design-Builder's comments without prejudice to Supplier's warranty or other obligations under this Purchase Order, Supplier shall so advise Design-Builder in writing within seven calendar days of its receipt of

Design-Builder's comments, stating the reasons therefore. Supplier may proceed with its Work to the extent of and in accordance with the annotated submittal only upon Design-Builder and Supplier resolving Design-Builder's comments.

1.04.02.03. Returned for Corrections (RC). Upon receipt of a submittal marked "Returned for Corrections," Supplier shall immediately take all necessary action to revise its submittal in accordance with Design-Builder's comments, the Specification, and the Drawings, and shall resubmit to Design-Builder for review the corrected original submittal, voiding previous information and adding new documents if required. In no event shall Supplier proceed with the affected Work until its revised submittals have been returned to Supplier marked "No Exceptions Noted" or "Exceptions Noted" by Purchaser.

1.04.02.04. Release for Record (RR). Receipt of a submittal marked "Release for Record" indicates that there are no specific objections to the document. Work may proceed. Certain project information required by the Design-Builder's document management system may have been added electronically to the drawing and provided to Supplier for the record. Supplier shall not resubmit the drawing or document unless revisions to the design are required. If revisions are required, Supplier shall incorporate Design-Builder's information and resubmit as a new revision. Design-Builder's project-specific information shall be added if future revisions and submittals are made.

1.04.02.05. Void (VO) or Superseded (SS). Receipt of a submittal marked "Void" or "Superseded" does not require any action by Supplier. "Void" indicates that the submittal is no longer applicable to the project and is not being replaced by other drawings or data. "Superseded" indicates that different drawings or data have replaced the previously submitted drawings and data; this status does not pertain to revisions of the same drawings and data.

1.04.02.06. Hold (HO). A submittal may be given a status of "Hold" by the Design-Builder, or the Supplier may have "Holds" on the submitted drawing.

For a Hold status designated by the Design-Builder, the Supplier shall not proceed with the work that is designated on "Hold" except as specifically directed by the Design-Builder. Additional information required for the Supplier to release the "Hold" will be transmitted from the Design-Builder later.

The Supplier shall provide information to the Design-Builder about the cause for any "Holds" designated on the drawing and immediately take all action necessary to resolve the "Holds". The Supplier shall resubmit the drawing for review once the "Holds" are removed from the drawing and should make all efforts to not submit drawings to the Design-Builder until drawing review comments have been received back from the Design-Builder.

1.04.02.07. Resubmittals. If during or subsequent to the completion of the submittal process, Supplier makes further changes to the equipment and materials shown on submittals that have been reviewed by Design-Builder, the changes shall be clearly marked on the submittal by Supplier and the submittal process shall be repeated. If changes are made by Supplier after delivery to the Jobsite, drawings conforming to construction records indicating the changes shall be prepared by Supplier and submitted to Design-Builder for review. Any resubmittal of information shall clearly identify the revisions by footnote or by a form of back-circle, with revision block update, as appropriate. The Supplier shall put the Black & Veatch drawing number on the transmittal letter and submit a complete document.

1.04.02.08. Design-Builder's Review. Design-Builder's review of drawings and other submittals will cover only general conformity of the data to the Specifications and Drawings, external connections, interfaces with equipment and materials furnished under separate specifications, and dimensions that affect plant arrangements. Design-Builder's review does not include a thorough review of all dimensions, quantities, and details of the equipment, material, device, or item indicated or the accuracy of the information submitted. Review and comment by Design-Builder of Supplier's Drawings or other submittals shall not relieve Supplier of its sole responsibility to meet the Completion Dates requirement of this Purchase Order and to supply Goods that conform to the requirements of this Purchase Order.

1.04.02.09. File Returns to Supplier. The Procore web service will be used by Design-Builder to return PDF files to Supplier.

Files returned to Supplier will be in PDF format.

2. OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The equipment Supplier shall prepare a Project specific operation and maintenance manual for each type of equipment indicated in the individual equipment sections or the equipment schedule.

Unless otherwise agreed by Design-Builder, the operation and maintenance manual for each type of equipment shall only be submitted for review following completion of review of all shop drawings and engineering data pertaining to that equipment.

Operation and maintenance manuals shall include the following:

a. Equipment function, normal operating characteristics, and limiting conditions.

b. Assembly, installation, alignment, adjustment, and checking instructions.

c. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

d. Lubrication and maintenance instructions.

e. Guide to troubleshooting.

f. Parts lists and predicted life of parts subject to wear.

g. Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

h. Test data and performance curves, where applicable.

i. Electronic file of Computer Maintenance Management System (CMMS) input data with all required preventative maintenance for seamless transition to incorporate into CMMS database.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by Design-Builder.

Manuals shall be submitted in electronic format to Design-Builder prior to the date of shipment of the equipment and as indicated in the Schedule of Submittals. The manuals shall be submitted and Design-Builder's review comments retrieved, through Procore accessible through the Internet. When review by Design-Builder is complete, the electronic O&M manual shall be delivered on Procore to Design-Builder. Delivery of the final O&M shall be made in accordance with the Schedule of Submittals section.

All material shall be marked with Project identification, and inapplicable information shall be marked out or deleted.

Shipment of equipment will not be considered complete until all required manuals and data have been received.

2.01. Electronic Operation and Maintenance Manuals. Electronic manuals shall be in Portable Document Format (PDF) and shall be prepared at a resolution between 300 and 600 dots per inch (dpi), depending on document type. Optical Character Recognition (OCR) capture shall be performed on these documents. OCR settings shall be performed.

Documents prepared in PDF format shall be processed as follows, unless acceptable to the submittal reviewer:

1. Pages shall be searchable (processed for optical character recognition) and indexed when multiple files are required.

2. Pages shall be rotated for viewing in proper orientation.
3. A bookmark shall be provided in the navigation frame for each entry in the Table of Contents.
4. Embedded thumbnails shall be generated for each completed PDF file.
5. The opening view for PDF files shall be as follows:
   Initial View: Bookmarks and Page
   Page Number: Title Page (usually Page 1)
   Magnification: Set to Fit in Window
   Page: Single Page
6. Where the bookmark structure is longer than one page the bookmarks shall be collapsed to show the chapter headings only.
7. When multiple files are required the first file of the series (the parent file) shall list every major topic in the Table of Contents. The parent file shall also include minor headings bookmarked based on the Table of Contents. Major headings, whose content is contained in subsequent files (children) shall be linked to be called from the parent to the specific location in the child file. The child file shall contain bookmark entries for both major and minor headings contained in the child file. The first bookmark of any child file shall link back to the parent file and shall read as follows "Return to the *Equipment Name* Table of Contents", e.g. Return to the Polymer Feed System Table of Contents.
8. Drawings shall be bookmarked individually.
9. Files shall be delivered without security settings to permit editing, insertion and deletion of material to update the manual provided by the manufacturer.

2.02. Labeling. As a minimum, the following information shall be included on all final O&M manual materials:

Equipment name and/or O&M title spelled out in complete words.
Project Name.
Owner Project/Contract Number.
Specification Section Number. Example: “Section 15500”
Manufacturer’s name.
File Name and Date.

For example:

MBR Operation and Maintenance Manual
Morro Bay WRF
Project/Contract No. 400530
Specification Section 46 61 35
Manufacturer
OM11110-001.pdf, 5/05/07

End of Section

Section 01 45 33.3

CODE REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 - GENERAL

1-1. SCOPE. Owner, or Registered Design Professional in Responsible Charge of construction acting as Owner's Agent, will engage one or more Approved Agencies to conduct tests and special inspections specified in this section and related sections, and as may be specified in other sections of these specifications. The Approved Agency shall not be employed by Design-Builder or a supplier materially participating in the project.

1-2. GENERAL. This Section includes administrative and procedural requirements indicated in the governing building code.

Structural testing and special inspection services are required to verify compliance with the construction documents and standards referenced herein.

1-3. DEFINITIONS.

Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the Authority Having Jurisdiction.

Approved Fabricator: An established and qualified person, firm or corporation registered and approved by the Authority Having Jurisdiction to perform work without Special Inspection.

Authority Having Jurisdiction (AHJ): The officer or other designated authority charged with the administration and enforcement of the building code, or a duly authorized representative. Also commonly known as the Building Official.
Construction Documents: Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit. Construction documents include all supplemental instructions, sketches, addenda, and revisions to the drawings and specifications issued by the Registered Design Professional beyond those issued for a building permit.

Pre-Engineered Structural Elements: Structural elements specified by the Registered Design Professional but which may be designed by another Registered Design Professional. (Examples are items such as open web steel joists and joist girders, metal joists, pre-cast concrete elements, pre-fabricated metal buildings, pre-stressed wire wrapped tanks, tilt-up concrete panel reinforcement and lifting hardware.)

Registered Design Professional (RDP): An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

Registered Design Professional in Responsible Charge (RDPRC): A Registered Design Professional engaged by Owner to review and coordinate certain aspects of the project, as determined by the AHJ and Construction Documents, for compatibility with the design of the buildings or structure, including submittal documents prepared by others, deferred submittal documents and phased submittal documents.

Shop Drawings / Submittal Data: Written, graphic and pictorial documents prepared and / or assembled by Design-Builder or Supplier based on the Construction Documents.

Special Inspection: Inspection and/or testing required by the governing building code, as amended by the AHJ, of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved Construction Documents and referenced standards.

Special Inspection, Continuous: The full-time observation or testing of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed.

Special Inspection, Periodic: The part-time or intermittent observation or testing of work requiring Special Inspection by an approved Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.

Special Inspector: A qualified person demonstrating competence, to the satisfaction of the AHJ and RDPRC, for inspection of the particular type of construction or operation requiring special inspection. The Special Inspector will be qualified as specified herein.

Structural Observations: Visual observation of the structural system by a Registered Design Professional for general conformance to the approved Construction Documents. Structural observations are not considered part of the tests and special inspections and do not replace inspections and testing by the Approved Agency. Owner will employ a RDP to perform Structural Observations.

Testing Agency: A qualified materials testing laboratory under the responsible charge of a Registered Design Professional, approved by the AHJ and the RDPRC, to measure, examine, test, calibrate, or otherwise determine the

characteristics or performance of construction materials and verify confirmation with construction documents.

1-4. INSPECTION AND TESTING AGENCY QUALIFICATIONS. Special Inspectors and testing agencies will be employed or retained by Owner, and will have the minimum qualifications as described in this section. The qualifications of all personnel performing special inspection and testing activities are subject to the approval of the AHJ.

Minimum qualifications of inspection and testing agencies and their personnel will comply with ASTM E329 “Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection,” or IAS AC 291 “Accreditation Criteria for Special Inspection Agencies.”

Inspectors and individuals performing tests will be certified for the work being performed as listed below and in Table 1 of IAS AC291, or by alternate certifications when acceptable to the AHJ. The AHJ may have additional requirements.

Abbreviation used in this Section	**Description**
AOR	Architect licensed in the state of the project, specializing in the design of building structures
Licensed Engineers	
PE/SE	Structural Engineer (SE) or Professional Engineer (PE) licensed in the state of the project, specializing in the design of building structures
PE/GE	Geotechnical Engineer (GE) or Professional Engineer (PE) licensed in the state of the project, specializing in soil mechanics and foundations
PE/EE	Electrical Engineer (EE) or Professional Engineer (PE) licensed in the state of the project, specializing in electrical systems
PE/ME	Mechanical Engineer (ME) or Professional Engineer (PE) licensed in the state of the project, specializing in mechanical systems
EI/EIT	Engineering Intern or Engineer-in-Training: a graduate engineer who has passed the Fundamentals of Engineering examination working under the direct supervision of a Professional Engineer licensed in the state of the project and with a minimum of one year of experience performing inspections.
American Concrete Institute (ACI) Certification	
ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector

Abbreviation used in this Section	Description
ACI-LTT	Laboratory Testing Technician – Grade 1 or 2
ACI-STT	Strength Testing Technician
American Welding Society (AWS) Certification	
AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector
American Society of Non-Destructive Testing (ASNT) Certification	
ASNT	Non-Destructive Testing Technician For Ultrasonic Testing (UT) and Radiographic Testing (RT) Certified as Level III through examination by ASNT or certified as Level II by their employer for flaw detection. For Magnetic Particle Testing (MT) and Liquid Penetrant Testing (PT) certified as Level II by their employer or certified as Level III through examination by ASNT and certified by their employer
International Code Council (ICC) Certification	
ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fire-proofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector
ICC-SBSI	Structural Steel and Bolting Special Inspector
ICC-WSI	Structural Welding Special Inspector
National Concrete Masonry Association	
NCMA	Concrete Masonry Testing Technician
National Institute for Certification in Engineering Technologies (NICET)	
NICET-CT	Concrete Technician – Levels II, III & IV
NICET-ST	Soils Technician - Levels II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels II, III & IV
Exterior Design Institute (EDI) Certification	
EDI-EIFS	EIFS Third Party Inspector

Inspection or Testing Item	Qualification Standards
Fabricators	Varies by product as listed below
Steel Construction – Welding Inspection	ICC-SWSI, ICC-WSI, AWS-CWI or AWS/AISC-SSI
Steel Construction – Non-Destructive Weld Testing	ASNT
Steel Construction – Details	PE/SE, ICC-SWSI, ICC-SBSI or AWS/AISC-SSI
Steel Construction – High Strength Bolts	PE/SE or ICC-SBSI
Concrete Construction - Field Tests	ACI-CFTT or NICET-CT
Concrete Construction - Field Inspection	PE/SE, ICC-RCSI, ACI-CCI or NICET-CT
Concrete Construction - Laboratory Testing	ACI-LTT, ACI-STT or NICET-CT
Prestressed Concrete Construction	ICC-PCSI
Masonry Construction - Field Inspection	PE/SE or ICC-SMSI
Masonry Construction - Laboratory Testing	NCMA
Soils (special grading, excavation and filling)	PE/GE, NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Pile Foundations	PE/GE, Appropriate structural material inspection and NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Pier Foundations	PE/GE, Appropriate structural material inspection and NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Wall Panels and Veneers	ICC-SMSI
Sprayed Fire-Resistant Materials	ICC-SFSI
Exterior Insulation and Finish Systems (EIFS)	ICC Building Inspector or EDI-EIFS
Post Installed Anchors in Concrete	ICC Building Inspector, ICC-RCSI, or PE/SE
Post Installed Anchors in Masonry	ICC Building Inspector, ICC-SMSI, or PE/SE
Smoke Control Systems	IBC 1705.18.2
Other Architectural Systems	ICC Building Inspector, AOR, or PE/SE
Mechanical Systems	ICC Building Inspector or PE/ME
Electrical Systems	See NFPA 70

1-4.01. Structural Steel Testing Agency Requirements. Submit the following to the RDPRC and the AHJ prior to beginning testing:

Written practices for monitoring and control of the inspection and testing agency operations including:

Inspection and testing agency's procedures for the selection and administration of inspection personnel, describing the training, experience, and examination requirements for qualification and certification of inspection personnel.

Inspection and testing agency's inspection procedures, including general inspection, material controls, and visual welding inspection.

Qualifications of management and quality assurance personnel designated for the project.

Qualification records for inspectors and NDT technicians designated for the project.

NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.

1-5. CONFLICTING REQUIREMENTS, REPORTS AND TEST RESULTS.

1-5.01. General. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the RDPRC for a decision before proceeding.

1-5.02. Minimum Quantity or Quality Levels. The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the RDPRC for a decision before proceeding.

1-6. TECHNICAL ATTACHMENTS. The following forms are required as part of the comprehensive administrative, testing and inspection requirements. The forms are available from the AHJ, or are included herein, as indicated:

Form Title	AHJ Provided	Included Herein	Notes

Form Title	AHJ Provided	Included Herein	Notes
Statement of Special Inspections (SSI)		x	To be completed jointly by the RDPRC and the Approved Agency, and sealed by the RDPRC after completion. Design-Builder or Owner shall submit the form to the AHJ as part of the building permit application process.
Request for Approval of Special Inspector	x		To be completed by Approved Agency. Approved Agency will submit the form to the AHJ and RDPRC for their approval of individual inspectors.
Request for Approval to Provide Special Inspection of Non-Local Fabrication	x		To be completed by Approved Agency and submitted to Owner, AHJ and RDPRC.
Design-Builder's Statement of Responsibility	x		To completed by Design-Builder and his relevant suppliers and submitted to Owner and AHJ.
Fabricator's Certificate of Compliance	x		To be completed by Design-Builder's fabricators, as applicable, and submitted to AHJ.
Final Report of Special Inspections	x		To be completed and sealed by Approved Agency. Approved Agency or Owner will submit to AHJ at the completion of construction.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3-1. DESIGN-BUILDER AND FABRICATOR RESPONSIBILITIES. Each Fabricator or Design-Builder responsible for the construction of a seismic-force-resisting system, designated seismic system, seismic resisting component, main wind force-resisting system, or a wind-resisting component listed in the SSI shall submit a Design-Builder's Statement of Responsibility to the AHJ and to Owner prior to the commencement of work.

To be considered an Approved Fabricator that may perform work without Special Inspection, the Fabricator shall submit copies of certifications from the International Accreditation Service (IAS) or other recognized and acceptable accreditation organization a minimum of 30 days prior to the start of fabrication. Acceptance as an Approved Fabricator is subject to approval by the AHJ. If the project specifications required an Approved Fabricator, and the AHJ does not accept the Fabricator as an Approved Fabricator, special inspection may become necessary in the fabricator's shop. Such inspections will be performed by Approved Agency.

Design-Builder shall assist in coordination of the inspection and testing services with the progress of the work. Design-Builder shall provide sufficient notice to allow proper scheduling of all inspection and testing personnel. Design-Builder shall provide safe access to inspection and testing personnel and shall ensure that all work requiring special inspection is inspected and/or tested prior to concealment.

Design-Builder shall submit schedules to Owner, RDPRC and testing and inspecting agencies. Schedules will note milestones and durations of time for materials requiring tests and special inspections.

Design-Builder shall provide the Special Inspector access to approved plans at the job site or fabrication shop as applicable.

Design-Builder shall retain at the job site or fabrication shop, as applicable, all special inspection records submitted by an Approved Agency or Special Inspector and shall provide these records for review by the AHJ's inspector upon request.

3-2. APPROVED AGENCY AND SPECIAL INSPECTOR RESPONSIBILITIES.

3-2.01. Preliminary Approvals. Not used.

3-2.02. Perform Inspections and Tests. Be present for and perform continuous or periodic inspections and tests as listed in the SSI for conformance of the work to the AHJ approved Construction Documents. Notify Design-Builder personnel of their presence and responsibilities. Reference the applicable "Code or

Standard Reference" column in the SSI for the minimum level of inspections and testing. When the SSI column titled "Code or Standard Reference" indicates "Manufacturer's research reports", inspector will obtain the most current ICBO-ES Report, ICC-ES Legacy Report, ICC-ES Report, or IAPMO UES Evaluation Report (as applicable) prior to the applicable inspection, for the type and brand of products or materials being inspected.

Provide additional inspections and testing as necessary to determine compliance with the Construction Documents. Perform special inspections in a timely manner to avoid delay of work.

The Approved Agency shall be responsible to insure that any non-local inspection/testing agency fully complies with this Section and the SSI.

3-2.03. Defective Work. Immediately notify Design-Builder of the need for corrective action when work does not conform to Construction Documents.

3-2.04. Uncorrected Defective Work. Notify the AHJ and RDPRC when deficiencies have not been corrected. Notice will be made prior to the completion of that phase of the work.

3-2.05. Interim Inspection Reports. Furnish interim inspection reports to the AHJ, the RDPRC, Design-Builder, and Owner during the progress of the work. Frequency of reports will be as established in the SSI. Reports will indicate that work inspected was done in conformance to the approved Construction Documents, or that the work was defective, as applicable.

Special inspection reports and test results will include, but not be limited to, the following:

Project name and address.

Permit number.

Special Inspection Agency name, address, and phone number.

Unique identification of the report and of each page.

Date and time of inspection.

Description of inspections or tests performed, including item description and location (reference grid lines, floors, elevations, etc.). Identify approved agencies employed to carry out tests.

Identification of test/inspection equipment used.

Statement noting that the work, material, and/or product conforms or does not conform to the construction document requirements. Describe defective items.

Name and signature of Design-Builder's representative who was notified of work, material, and/or products that do not meet the construction document requirements.

Name and signature of Special Inspector and/or testing agency representative performing the work.

3-2.06. Report of Defective Work. Each agent will maintain a log that identifies work that does not meet the requirements of the construction documents. Include:

Description and exact location.

Reference to applicable drawings and specifications.

Reference to original inspection/test report and subsequent dates of re-inspection/retesting.

Name and title of each individual notified and method of notification.

How defective items were resolved or unresolved, as applicable.

Itemized changes authorized by the RDPRC and AHJ if not included in a defective item.

3-2.07. Submittal Schedule. Documentation of reports, test results, and non-compliant work will be submitted at the frequency indicated in the SSI.

3-2.08. Final Report of Special Inspections. Each agent listed in the SSI shall submit a final report to the Approved Agency documenting the performed special inspections and the correction of any discrepancies noted. The Approved Agency shall cumulate the reports and submit a comprehensive final report at a point in time as agreed upon by the permit applicant and the AHJ prior to the start of work.

3-3. STRUCTURAL OBSERVATION. Owner, or RDPRC on Owner's behalf, shall employ a RDP to perform Structural Observation. Prior to the commencement of observations, the structural observer shall submit to the AHJ a written statement identifying the frequency and extent of structural observations. Structural observations may be made periodically as determined by the Registered Design Professional.

At the conclusion of the work requiring observation, the structural observer shall submit to the AHJ a written statement that the site visits have been made and identify any reported deficiencies which, to the best of the structural observer's knowledge, have not been resolved.

Statement of Special Inspections

Project:
Project Address:
Permit Applicant:
Applicant Address:
Owner:
Owner Address:

Registered Design Professional in Responsible Charge (RDPRC) :

Discipline	Name	License Number	Expiration Date
Structural Engineer			
Geotechnical Engineer			
Mechanical Engineer			
Electrical Engineer			
Architect			

This Statement of Special Inspections includes a *Schedule of Special Inspections* applicable to the above referenced project as well as the identity of the individuals, agencies, or firms intended to be retained for conducting these inspections.

The Special Inspector(s) shall keep records of all inspections and shall furnish interim inspection reports to the Authority Having Jurisdiction (AHJ) and to the Registered Design Professional in Responsible Charge (RDPRC). Discrepancies shall be brought to the immediate attention of the Design-Builder for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the AHJ and the RDPRC prior to completion of that phase of work. A *Final Report of Special Inspections* documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted by each agent.

The Special Inspection program does not relieve the Design-Builder of the responsibility to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Design-Builder.

Inspection work shall be performed in accordance with the following codes and standards. Unless otherwise indicated within the Statement of Special Inspections, the applicable edition for all codes and standards shall be as follows.

Work	In Accordance With
Building Code	2016 California Building Code (CBC)
Seismic Criteria for Nonstructural Components	ASCE 7-10
Standard Tests and Practices	Listed American Society for Testing and Materials (ASTM) specifications
Concrete	ACI 318-14 and ACI 350-06
Masonry	ACI 530-13 and ACI 530.1-13
Structural Steel	AISC 360-10 and AISC 341-10

Work	In Accordance With
Structural steel welding	AWS D1.1 Structural Welding Code - Steel
Aluminum welding	AWS D1.2 Structural Welding Code – Aluminum
Sheet steel welding	AWS D1.3 Structural Welding Code – Sheet Steel
Structural steel bolting	Research Council on Structural Connections Specification for Structural Joints Using High Strength Bolts, December 31, 2009
Intumescent Fire-Resistive Coating	Association of the Wall and Ceiling Industry (AWCI) Technical Manual 12-B, Second Edition; Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials; an Annotated Guide

RDPRC - Structural	RDPRC - Civil/Geotechnical	RDPRC - Mechanical
RDPRC – Electrical	RDPRC - Architect	

Owner's Acknowledgement:

Signature Date

Acceptance by Authority Having Jurisdiction:

Signature Date

Permit No.

Frequency of interim report submittals to AHJ:

☐ 1 week ☐ 2 weeks ☐ Monthly ☐ Bi-Monthly ☐ At Completion ☐ Per attached Schedule

Statement of Special Inspections
(Schedule of Inspections)

The attached tables as listed below define the applicable Special Inspections and Procedures.

Table 1 of 9	Geotechnical Special Inspections
Table 2 of 9	Structural Special Inspections
Table 3 of 9	Architectural Special Inspections
Table 4 of 9	Inspections for Special Cases
Table 5 of 9	Testing for Special Inspections
Table 6 of 9	Special Inspections for Seismic Resistance
Table 7 of 9	Testing for Seismic Resistance
Table 8 of 9	Special Inspections for Wind Resistance – NOT USED
Table 9 of 9	Inspection Agents

The Seismic Design Category for the project is D.

Schedule of Special Inspections - Table 1 of 9 (Geotechnical Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Soils						
Verify material below foundation is adequate to achieve design bearing capacity, free of loose, deleterious or foreign material.	1705.6	Geotechnical Report		**X** (foundation excavation complete)		
Verify excavations are extended to proper depth, proper size and material.	1705.6	Geotechnical Report		**X** (foundation excavation complete)		
Prior to placement of controlled fill, inspect subgrade and verify site is properly prepared.	1705.6	Geotechnical Report		**X** (prior to placement of fill)		
Perform classification and testing of compacted fill material.	1705.6	Geotechnical Report		**X** (during placement of fill)		
Verify materials, densities, and lift thicknesses during placement and compaction of controlled fill for foundations.	1705.6	Geotechnical Report	**X**		Note the exception of Article 1705.6.	
Driven Deep Foundation Elements NOT USED						
Cast-in-Place Deep Foundation Elements (Auger Cast Piles and Drilled Piers)NOT USED						
Helical Pile Foundations NOT USED						
Screw Anchors NOT USED						
Mechanically Stabilized Earth (MSE) Retaining Walls NOT USED						
Tension Anchors NOT USED						
Stone Columns NOT USED						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Structural Load-Bearing Members Fabricated in a Shop						
If registered and approved by the AHJ to perform work without special inspection, submit "Fabricator's Certificate of Compliance" at the completion of work that fabricated items were constructed in accordance with the approved construction documents.	1704.2.5.1 1704.5 1705.10			**X** (at end of fabrication)		N/A
Concrete						
Reinforcing steel and prestressing tendon condition (free of oil, dirt and loose rust and that properly coated and/or sheathed) and placement. Verify size, spacing, bar clearances, cover, and adequate support to prevent displacement during concrete placement. Verify lap splices, mechanical splices, and embedment lengths. Verify dowels for work above are properly aligned and spaced to match other work.	1705.3	ACI 318 (Ch. 20) ACI 318 (25.2-25.3) ACI 318 (26.6.1-26.6.3		**X** (prior to closing of forms or delivery of concrete, for each placement)		
Anchors cast in concrete	1705.3	ACI 318 (17.8.2)		**X**	All bolts visually inspected to verify anchor diameter, location, and embedment length.	
Verify use of approved mix design(s).	1705.3 1904.1	ACI 318 (Ch. 19) ACI 318 (26.4.3-26.4.4)		**X**	RDPRC to approve Design-Builder's proposed mix design prior to construction. Inspector to verify from concrete delivery ticket that the appropriate mix has been provided prior to placement.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Formwork shape, location, and dimensions of the concrete member being formed, construction joints properly prepared.	1705.3	ACI 318 (26.11.1.2(b)		**X** (prior to delivery of concrete for each placement)		
Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content test, and determine the temperature of the concrete.	1705.3	ASTM C31 ASTM C172 ACI 318 (26.12)		**X**	Sampling and testing frequency shall be as indicated in the cast-in-place concrete specification.	
Concrete placement.	1705.3	ACI 318 (26.5.2)	**X**		Verify that water added at the site does not exceed that allowed by the mix design. Verify conveying, depositing, and consolidation of concrete. Observe placement procedures for evidence of segregation, possible cold joints, displacement of reinforcing or forms, and proper support of embedded items, anchor bolts, etc.	
Concrete curing – maintain temperature and techniques.	1705.3	ACI 318 (26.5.3-26.5.5)		**X** (during hot, cold, and windy conditions)	For wet-curing, check at the beginning of each day during 7 day curing period	
Verification of in-situ concrete strength prior to removal of forms and shores from elevated beams and slabs.	1705.3	ACI 318 (26.11.2)		**X** (prior to form or shore removal)		
Verification of in-situ concrete strength prior to backfilling against walls.				**X** (prior to backfilling operations)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Shotcrete NOT USED						
Masonry for Occupancy Category I, II, or III Structures						
Verification of proportions for site-prepared mortar and grout.	1705.4	ACI 530.1 (2.1) ACI 530.1 (2.6A) ACI 530.1 (2.6B)		**X** (at beginning of masonry construction and prior to grouting)		
Verification of proportions of materials in premixed or preblended mortar and grout as delivered to the site.				**X** (at beginning of masonry construction and prior to grouting)	RDPRC to approve Design-Builder's proposed mix designs prior to construction. Inspector to verify from grout delivery ticket that the appropriate mix has been provided prior to placement.	
Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	1705.4	ACI 530.1 (1.5B.1.b.3)	**X**			
Verification of f'_m and f'_{AAC} prior to construction and for every 5000 square feet during construction.	1705.4	ACI 530.1 (1.4B)		**X**	Verification by unit strength or prism testing, see masonry specification.	
Placement of masonry units and mortar joint construction.	1705.4	ACI 530.1 (3.3B)		**X** (at beginning of masonry construction, once daily for each crew, and prior to grouting)	Inspect size, layout, bonding and placement of masonry units. Inspect construction of mortar joints including tooling and filling of head joints.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Verification of size and location of structural elements.	1705.4	ACI 530.1 (3.3F)		**X** (at beginning of masonry construction and prior to grouting)		
Anchors grouted in masonry and anchorage of masonry to frames, structural members, and diaphragms including type, size, and location of anchors.	1705.4	ACI 530 (6.2)		**X** (at beginning of masonry construction and prior to grouting)		
Type, grade, and size of reinforcing steel.	1705.4	ACI 530 (6.1) ACI 530.1 (2.4) ACI 530.1 (3.4)		**X** (when staged and prior to installation)		
Verify grout space is clean prior to grouting.	1705.4	ACI 530.1 (3.2D) ACI 530.1 (3.2F)		**X** (prior to each grouting operation)	Verify that cells and starting beds are clean.	
Reinforcing steel and connector placement: verify size, spacing, surface condition, correct location, type of embedments.	1705.4	ACI 530 (6.1) ACI 530.1 (3.2E) ACI 530.1 (3.4)		**X** (at beginning of masonry construction and prior to grouting)	Verify dowels and inserts are secured in place, particularly at roof lines, floor lines, and intersecting wall lines.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Grout placement.	1705.4	ACI 530.1 (3.5)	**X**		Verify that the grout lift height is in conformance with the code and specifications. Verify installation of cleanout closures. Verify that grouting operations are held below the top if keying is required for subsequent lifts, as required by code and specifications. Verify mechanical vibration during placement, and later during reconsolidation. Verify that curing requirements are being followed.	
Cold/hot weather masonry protection.	1705.4 2104.3 2104.4	ACI 530.1 (1.8C) ACI 530.1 (1.8D)		**X** (at beginning of each day's work)	When temperatures are expected to be below 40 degrees F or above 90 degrees F.	
Observe preparation of required grout specimens, mortar specimens, and/or prisms.	1705.4 2105.2.2 2105.3	ACI 530.1 (1.4)		**X**	Verification by unit strength or prism testing, see masonry specification.	
Masonry for Occupancy Category IV Structures NOT USED						
Steel						
Material verification of high strength bolts: Identification markings to conform to specified ASTM standards.	1705.2.1	Applicable ASTM material specifications AISC 360 (A3.3) AISC 360 (N3)		**X** (3 bolts from each lot)	Verified at jobsite.	
Material verification of high strength bolts: Manufacturer's certificate of compliance.	1705.2.1	AISC 360 (A3.3) AISC 360 (N3)		**X** (each lot)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Material verification of structural steel: Identification markings to conform to specified ASTM standards.	1705.2.1 2203.1	AISC 360 (A3.1) AISC 360 (N3)		**X** (3 pieces from each lot)	Verified at fabricator's shop prior to cutting.	
Material verification of structural steel: Certified mill test reports.	1705.2.1 2203.1	AISC 360 (A3.1) AISC 360 (N3)		**X** (each mill order)		
Material verification of anchor rods and threaded rods: Manufacturer's certified test reports.	1705.2.1	AISC 360 (A3.4) AISC 360 (N3)		**X** (each lot)		
Material verification of welding consumables: Identification markings to conform to specified AWS standards.	1705.2.1	AISC 360 (A3.5) AISC 360 (N3) AWS A5 documents		**X** (3 rods from each lot)	Verified at fabricator's shop and at jobsite.	
Material verification of welding consumables: Manufacturer's certificate of compliance.	1705.2.1	AISC 360 (A3.5) AISC 360 (N3) AWS D1.1 (6.2)		**X** (each lot)		
Verify use of proper WPS's.	1705.2.1	AISC 360 (N3) AWS D1.1 (6.3)		**X** (prior to start of work)	Obtain copy of welding procedure specifications.	
Verify welder qualifications.	1705.2.1	AISC 360 (N3) AWS D1.1 (6.4)		**X** (prior to start of each welder's work)	Obtain copy of qualification records.	
Complete and partial penetration groove welds.	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**		Inspect pre-heat, post-heat and surface preparation between passes.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Multipass fillet welds.	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**		Inspect pre-heat, post-heat and surface preparation between passes.	
Single pass fillet welds greater than 5/16".	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**			
Plug and slot welds.	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)	**X**			
Single pass fillet welds less than or equal to 5/16".	1705.2.1	AISC 360 (N5.4) AWS D1.1 (Section 6)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		
Installation of steel form decking: Verify deck type, depth, and gage.	1703.4.2 1705.1.1.3	Manufacturer's research report		**X** (when staged prior to installation, at completion, and as required by Mfr's research report)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Installation of steel roof decking: Verify deck depth and gage, powder actuated fasteners, screws, proprietary side seam attachments, and button punches.	1703.4.2 1705.1.1.3	Manufacturer's research report		**X** (when staged prior to installation, at completion, and as required by Mfr's research report)		
Floor and roof deck welds.	1705.2.2	SDI QA/QC inspection requirements		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		
Welding stair and railing systems.	1705.2.1	AWS D1.1 (Section 6.9)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)	Welding of the railing system required only at the base of cantilevered rail posts.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Observe high strength bolt preinstallation testing and calibration procedures.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 7)		**X** (3 complete fastener assemblies of each combination of diameter, length, grade, and lot to be used in the work)	Test in a tension calibrator at the site. Required pretension is equal to or greater than 1.05 times that specified for installation. Verify accuracy of the tension calibrator has been confirmed through calibration within previous 12 months.	
Snug-tight high strength bolt installation: All connections visually inspected. Connected materials drawn together and properly snugged.	1705.2.1	AISC 360 (M2.5) AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9)		**X** (observe once daily for each bolting crew and at completion of assembly installation)		
Pretensioned high strength bolt installation using turn-of-the-nut method with match marking, direct tension indicator method, or twist-off type tension control bolt method: Verify installation procedure, all plies drawn together and properly snugged, visually inspect all connections. Verify that splines have separated from tension control bolts.	1705.2.1	AISC 360 (M2.5) AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9)		**X** (observe once daily for each bolting crew and each assembly installation as noted in Remarks)	Turn-of-the-nut method with match marking: after pretensioning. Direct tension indicators: feeler gauge used after snugging and after pretensioning. Twist-off type tension control bolt: after pretensioning.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Pretensioned high strength bolt installation using turn-of-the-nut method without match marking or calibrated wrench method: Verify installation procedure, all plies drawn together and properly snugged, visually inspect all connections.	1705.2.1	AISC 360 (M2.5) AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9)	**X**			
Verification of frame joint details including application, component locations, bracing, and stiffening, proper application of joint details at each connection.	1705.2.1	AISC 360 (N5.7)		**X** (at 50% complete and 100% complete, for each structure)		
Open Web Steel Joists and Joist Girders NOT USED						
Cold-Formed Steel Framing						
Material verification of weld filler metals: Identification markings to conform to specified AWS standards.		AWS D1.3 (Section 6)		**X** (3 rods from each lot)	Checked at fabricator's shop and at jobsite.	
Material verification of welding consumables: Manufacturer's certificate of compliance.		AWS D1.3 (Section 6)		**X** (each lot)		
Verify use of proper WPS's.		AWS D1.3 (Section 6)		**X** (prior to start of work)	Obtain copy of welding procedure specifications.	
Verify welder qualifications.		AWS D1.3 (Section 6)		**X** (prior to start of each welder's work)	Obtain copy of qualification records.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Welded framing connections.		AWS D1.3 (Section 6)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		
Post-Installed Anchors – Expansion and Undercut Anchors into Concrete						
Verify anchor type, size, dimensions, location, spacing, edge distance, drill bit type, drill bit diameter, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report		**X**	Continuous inspection is required if mandated by manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Concrete						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Adhesive anchors installed in overhead, upwardly inclined, or horizontal positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report	X			
Adhesive anchors installed in other positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report		X	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically, unless continuous inspections are mandated by the manufacturer's research report. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection.	
Post-Installed Anchors – Expansion Anchors into Grouted Masonry						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Verify anchor type, size, dimensions, location, spacing, edge distance, drill bit type, drill bit diameter, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, mortar type, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		X	Continuous inspection is required if mandated by the manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Grouted Masonry						
Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		X	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection. Continuous inspection is required if mandated by the manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Hollow Masonry NOT USED						
Post-Installed Anchors – Adhesive Anchors into Unreinforced Brick Masonry NOT USED						
Aluminum NOT USED						

Schedule of Special Inspections - Table 3 of 9 (Architectural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Sprayed Fire-Resistant Materials NOT USED						
Mastic and Intumescent Fire-Resistive Coatings NOT USED						
Exterior Insulation and Finish Systems NOT USED						
Fire-Resistant Penetrations and Joints						
Penetration firestops (locations indicated on drawings).	1705.17.1	UL assemblies referenced in Drawings		X	Systems that are tested and listed in accordance with IBC Sections 714.3.1.2 and 714.4.2 shall be inspected in accordance with ASTM E2174.	
Fire-resistant joint systems (locations indicated on drawings).	1705.17.2	UL assemblies referenced in Drawings		X	Systems that are tested and listed in accordance with IBC Sections 715.3 and 715.4 shall be inspected in accordance with ASTM E2393.	
Smoke Control Systems						
Installation	1705.18			X	Record device location(s)	

Schedule of Special Inspections - Table 4 of 9 (Inspections for Special Cases)						
	Inspection					
System or Material	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
			Continuous	Periodic		
Pre-Engineered Structures						
Fabrication and erection	1705.1.1				Refer to Table 2 for fabricator, welding, and high strength bolting special inspection requirements	
Welded Steel Tanks						
Fabrication and erection	1705.1.1	AWWA D100, Section 11 API 650, 7.3 API 620, Section 5		**X** (per Table 2)	In addition to periodic inspection, all joints visually inspected prior to coating application. Refer to Table 2 for fabricator, welding, and high strength bolting special inspection requirements	
Mass Concrete Procedures NOT USED						

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Inspection				
System or Material	Building Code Reference	Code or Standard Reference	Frequency	Remarks	Inspection Agent No. (see Table 9)
Geotechnical					
Classification of controlled fill material.	1705.6	ASTM D2488	One per stratum of on-site excavated material. One per common supply of off-site material.	Per Geotechnical Report and excavation and fill for structures specification.	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
System or Material	**Inspection**			**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**		
Foundation subgrade, in-place density.	1705.6	ASTM D2922 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 1,000 SY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	Per Geotechnical Report and excavation and fill for structures specification.	
Controlled fill beneath foundations, in-place density.	1705.6	ASTM D2922 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 200 CY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	Per Geotechnical Report and excavation and fill for structures specification.	
Concrete					
Concrete strength.	1705.3	ASTM C31 ASTM C39 ASTM C172	See concrete specification	See concrete specification for quantity of cylinders.	
Concrete slump, air content, temperature, unit weight, water soluble chloride ion, shrinkage.	1705.3	ASTM C31 ASTM C138 ASTM C143 ASTM C157 ASTM C172 ASTM C231 ASTM C1064 ASTM C1218	See concrete specification		
Shotcrete NOT USED					
Masonry					
Unit strength.	2105.1	ASTM C140	See masonry specification		

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
System or Material	**Inspection**			**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**		
Mortar strength.	2105.1	ASTM C270	See masonry specification		
Grout strength.	2105.1	ASTM C1019	See masonry specification		
Prism strength.	2105.1	ASTM C1314	See masonry specification	Partially grouted walls require a set of tests for both the grouted and ungrouted conditions.	
Steel					
Liquid penetrant (PT), magnetic particle (MT), radiographic (RT) and ultrasonic (UT) testing of welds.	1705.2	PT – AWS D1.1 (6.10 & 6.14.5) MT - AWS D1.1 (6.10 & 6.14.4) RT – AWS D1.1 (6.12 & 6.14.1) UT - AWS D1.1 (6.13 & 6.14.3)		CJP and PJP groove welds, multipass fillet welds, single pass fillet welds larger than 5/16, and plug/slot welds.	
Aluminum NOT USED					
Welded Steel Tanks NOT USED					

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No.** (see Table 9)
Sprayed Fire-Resistant Materials NOT USED					
Intumescent Fire-Resistive Coatings NOT USED					
Smoke Control Systems					
Leakage and pressure differential and flow measurement.	1705.18.1		Determined by jurisdiction		
Detection and control verification.	1705.18.1		Determined by jurisdiction		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Structural Steel and Structural Steel Elements Within the Seismic Force-Resisting System (systems identified on the drawings)						
Visually inspect the following before welding: material type and grade; welder identification system; fit up of groove welds including joint preparation, dimensions, cleanliness, tacking, backing type and fit; configuration and finish of access holes; fit up of fillet welds including dimensions, cleanliness and tacking.	1705.12.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect during welding: WPS followed, use of qualified welders, control and handling of welding consumables, environmental conditions, welding techniques, no welding over cracked tacks.	1705.12.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect after welding: Welds cleaned, size, length, and location of welds.	1705.12.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Visually inspect welds after welding to acceptance criteria for: crack prohibition, weld/base metal fusion, crater cross section, weld profile, weld size, undercut, and porosity.	1705.12.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
Visually inspect welds after welding for placement of reinforcement fillets, removal of backing bars and weld tabs and finish (where required on drawings or per specifications), and repair activities.	1705.12.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
Prior to high strength bolting: verify proper fasteners and bolting procedures selected for the detail, connecting elements fabricated properly including faying surface preparation and hole preparation, proper storage for bolts, nuts, washers and other components.	1705.12.1	AISC 341 (J7)		**X** (Once daily for each bolting crew)		
During high strength bolting: Fasteners assemblies properly positioned, joints snug tight prior to pretensioning, fastener component not turned by the wrench prevented from rotating, pretensioning progresses systematically from most rigid point to free edges.	1705.12.1	AISC 341 (J7)		**X** (observe once daily for each bolting crew)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
After installation of high strength bolting, document accepted and rejected connections.	1705.12.1	AISC 341 (J7)		**X** (at completion of each connection)		
Verify no holes or unapproved attachments made in protected zone noted on the drawings.	1705.12.1	AISC 341 (J8)		**X** (observe once daily)		
Cold-Formed Steel Framing NOT USED						
Cold-Formed Steel Special Bolted Moment Frames NOT USED						
Architectural Components						
Anchorage of storage racks ≥ 8 ft in height.	1705.12.7	ASCE 7 (15.5.3)		**X** (observe once daily for each crew and visually inspect all connections at completion)		
Anchorage of access flooring.	1705.12.5.1	ASCE 7 (13.5.7)		**X** (visually inspect all connections at completion)		
Erection and fastening of exterior cladding.	1705.12.5			**X** (observe once daily for each crew and visually inspect all connections at completion)	Not required for cladding weighing 5 psf or less or for buildings less than 30 feet in height.	

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Erection and fastening of interior and exterior nonbearing walls.	1705.12.5			**X** (observe once daily for each crew and visually inspect all connections at completion)	Not required for interior nonbearing walls weighing 15 psf or less, and not required for interior or exterior nonbearing walls for buildings less than 30 feet in height.	
Placement and anchorage of interior and exterior veneer.	1705.12.5			**X** (observe once daily for each crew and visually inspect anchorage at completion)	Not required for veneer weighing 5 psf or less or for buildings less than 30 feet in height.	
Plumbing and Mechanical Components						
Installation and anchorage of equipment and piping for flammable, combustible, or highly toxic materials and associated mechanical units.	1705.12.6			**X** (observe once daily for each crew and completed installation of each applicable piece of equipment and piping)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Installation and anchorage of HVAC equipment and ductwork containing hazardous materials and anchorage of such ductwork.	1705.12.6			**X** (observe once daily for each crew and completed installation of each applicable piece of equipment)		
Installation and anchorage of vibration isolation systems, where nominal clearance between equipment and support frame and restraint is 0.25 inches or less.	1705.12.6			**X** (observe once daily for each crew and completed installation of each applicable piece of equipment)		
Electrical						
Anchorage of electrical equipment for emergency and standby power.	1705.12.6			**X** (observe completed installation of each applicable piece of equipment)	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components that must be anchored.	

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Anchorage of other electrical equipment.	1705.12.6			**X** (observe completed installation of each applicable piece of equipment)	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components that must be anchored.	
Nonstructural Components						
For non-structural components that are qualified by means of shake table testing or experience data, verify that the label, anchorage, and mounting conform to the certificate of compliance furnished by the product manufacturer.	1705.12.4	ASCE 7 (13.2.2)		**X** (Each applicable piece of equipment)	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components and their anchorages that must be qualified.	
Seismic Isolation Systems NOT USED						
Energy Dissipation Systems NOT USED						

Schedule of Special Inspections - Table 7 of 9 (Testing for Seismic Resistance)					
	Inspection				
System or Material	Building Code Reference	Code or Standard Reference	Frequency	Remarks	Inspection Agent No. (see Table 9)
Concrete NOT USED					
Structural Steel and Structural Steel Elements Within the Seismic Force-Resisting System (systems identified on the drawings)					
Ultrasonic (UT) of base metal thicker than 1-1/2" subject to through-thickness weld shrinkage strains. Test is for discontinuities behind and adjacent to each weld.	1705.13.1	AWS D1.1(6.13 & 6.14.3)	Each weld		
When welding doubler, continuity, or stiffener plates in the k-area of a web, test the web for cracks using magnetic particle testing (MT).	1705.13.1	AISC 341 (J6.2)	Each plate location	Inspection area shall include the k-area base metal within 3 inches of the weld. Testing shall be performed no sooner than 48 hours following completion of the welding.	
For CJP groove welds in material 5/16” thick and greater, perform ultrasonic testing (UT).	1705.13.1	AISC 341 (J6.2)	Each weld	Weld discontinuities shall be accepted or rejected on the basis of critiera of AWS D1.1 Table 6.2. In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for possible reduction in testing frequency.	
For beam to column CJP groove welds, perform magnetic particle testing (MT).	1705.13.1	AISC 341 (J6.2)	25% of all such welds for each welder	In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for permitted reduction in testing frequency.	

Schedule of Special Inspections - Table 7 of 9 (Testing for Seismic Resistance)					
System or Material	**Inspection**			**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**		
When base metal thicker than 1-1/2" is loaded in tension in the through-thickness direction in tee and corner joints, where the connected material is greater than 3/4" thick and contains CJP welds, perform ultrasonic testing (UT) to detect discontinuities behind and adjacent to the fusion line of each weld.	1705.13.1	AISC 341 (J6.2)	Each weld	See AISC 341 for permitted reduction in testing frequency.	
For welded splices and connections, perform magnetic particle testing (MT) or liquid penetrant testing (PT) at thermally cut surfaces of beam copes and access holes when the flange thickness exceeds 1-1/2" for rolled shapes or the web thickness exceeds 1-1/2" for built-up shapes.	1705.13.1	AISC 341 (J6.2)	Each weld		
For welds where weld tabs have been removed, except for continuity plate weld tabs, perform magnetic particle testing (MT) on the ends of the weld.	1705.13.1	AISC 341 (J6.2)	Each weld or location	See AISC 341 for permitted reduction in testing frequency.	
Pre-installation testing of fastener assemblies and methods used.	1705.13.1	AISC 341 (J7) RCSC Specification for Structural Joints Using High Strength Bolts (Section 7)	3 assemblies of each diameter, grade, length, and lot prior to use		
Non-Structural Components (Architectural, Mechanical and Electrical)					
For non-structural components and their anchorage that are qualified by means of analysis, testing, or experience data, examine the certificate of compliance furnished by the product manufacturer.	1705.13.2 1705.13.3	ASCE 7 (13.2.1, part 2), ASCE 7 (13.2.2 parts 1, 2)	Each applicable piece of equipment	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components and their anchorages that must be qualified.	

Schedule of Special Inspections - Table 7 of 9 (Testing for Seismic Resistance)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No.** (see Table 9)
Seismic Isolation Systems NOT USED					

Schedule of Special Inspections - Table 8 of 9 (Special Inspections for Wind Resistance) NOT USED						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (See Table 9)

Schedule of Special Inspections - Table 9 of 9 (Inspection Agents)					
AGENT NAME	**LICENSE NO.**	**FIRM**	**ADDRESS**	**EMAIL**	**TELEPHONE NO.**
1.					( )
2.					( )
3.					( )
4.					( )
5.					( )
6.					( )
7.					( )
8.					( )
9.					( )
10.					( )

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Section 01 61 00

GENERAL EQUIPMENT STIPULATIONS

1. SCOPE. When an equipment specification section in this Contract references this section, the equipment shall conform to the general stipulations set forth in this section, except as otherwise specified in other sections.

2. COORDINATION. The equipment suppliers and vendors shall coordinate all details of their equipment and packages with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible with the overall Balance of Plant. The equipment suppliers and vendors are responsible for pointing out where their equipment deviates from the Design-Builder procurement package, drawings and specifications.

3. MANUFACTURER'S EXPERIENCE. Unless specifically named in the Specifications, a manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

4. WORKMANSHIP AND MATERIALS. The equipment suppliers shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick. When dissimilar metal components are used, consideration shall be given to prevention of galvanic corrosion.

5. STRUCTURAL DESIGN REQUIREMENTS. All equipment, including non-structural components and non-building structures as defined in ASCE 7, and their anchorage, shall be designed and detailed in accordance with the Meteorological and Seismic Design Criteria section.

6. LUBRICATION. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Design-Builder. Lubricants for equipment where the lubricants may come in contact with water before or during a potable water treatment process or with potable water, shall be food grade lubricants. This includes lubricants for equipment not normally in contact with water, but where accidental leakage of the lubricants may contaminate the water.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

7. ELEVATION. The elevation of the site shall be as indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished shall be designed to meet stipulated conditions and to operate satisfactorily at the specified elevation.

8. ELECTRIC MOTORS. Unless otherwise specified, motors furnished with equipment shall meet the requirements specified in Common Motor Requirements for Process Equipment section or specified in specific equipment sections.

9. DRIVE UNITS. The nominal input horsepower [kW] rating of each gear or speed reducer shall be at least equal to the nameplate horsepower [kW] of the drive motor. Drive units shall be designed for 24 hour continuous service.

9.01. Gearmotors. The use of gearmotors sharing an integral housing or cutgears into the motor output shaft, or that require removal of lubricant from the gear reducer to change out the motor will not be acceptable.

9.02. Gear Reducers. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout.

Unless superseded by individual specification requirements each helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower [kilowatts] of the drive motor. Cycloidal gear reducers shall have a service factor of at least 2.0 based on the nameplate horsepower [kW] of the drive motor. Shaft-mounted and

flange-mounted gear reducers shall be rated AGMA Class III. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall be designed and manufactured in compliance with applicable most current AGMA standards.

The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F.

Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing. The use of permanently sealed, grease lubricated bearings will not be acceptable in large sized reducers. In small reducers, similar to basin equipment, permanently sealed grease lubricated bearings may be provided at the manufacturer's option. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings. A dipstick or a sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.

Gear reducers which require the removal of parts or the periodic disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.

9.03. Variable Speed Drives. Each mechanical variable speed drive shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor. A spare belt shall be provided with each adjustable speed drive unit employing a belt for speed change. Unless specifically permitted by the detailed equipment specifications, bracket type mounting will not be acceptable for variable speed drives.

9.04. V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor.

10. SAFETY GUARDS. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated to a thickness as required per Cal-OSHA, galvanized, aluminum-clad sheet steel, or stainless sheet steel or from 1/2 inch mesh galvanized expanded metal, or pultrusion molded UV resistant materials. Each safety guard shall be reinforced or shaped to provide suitable strength to prevent vibration and deflection and shall comply with Cal-OSHA. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories,

including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

11. ANCHORAGE AND ANCHOR BOLTS. Equipment suppliers shall design and detail suitable anchor bolts for each item of equipment. Anchor bolts shall be designed for all operating conditions of the equipment, including wind, vibration and seismic loadings. Wind and seismic loads shall be as indicated in the Meteorological and Seismic Design Criteria section. Anchor bolt design shall be sealed by a registered professional engineer licensed in the State of California.

Requirements for anchor bolt type, material, and minimum diameter shall be as indicated in the Anchorage in Concrete and Masonry section.

Anchor bolts templates and/or setting drawings shall be submitted early to permit purchase of the anchor bolts by the Design-Builder and to permit setting the anchor bolts when the structural concrete or masonry grout is placed.

Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

12. EQUIPMENT BASES. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches high by the Design-Builder. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in the Grouting section by the Design-Builder.

13. SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

14. SHOP PAINTING AND COATING. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth,

uniform base for painting. All shop fabricated equipment shall be provided with final coating in the shop.

Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed and shop finished with an epoxy or polyurethane enamel or universal type primer suitable for top coating with an aliphatic polyurethane system.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the equipment manufacturer.

15. LABELING AND TAGGING. Equipment labeling and tagging shall be in accordance with the Equipment and Valve Identification section.

16. PREPARATION FOR SHIPMENT. Equipment shall be prepared for shipment as specified in the Supplementary Terms and Conditions section.

17. STORAGE. Handling and storage of equipment once on site shall be as determined by the Design-Builder and coordinated with the suppliers.

18. INSTALLATION AND OPERATION. Installation and operation shall be as specified in respective equipment sections and the Startup Requirements section.

19. OBSERVATION OF PERFORMANCE AND ACCEPTANCE TESTS. Performance and Acceptance tests shall be coordinated and observed or witnessed by the Design-Builder where indicated in the Specifications.

End of Section

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Section 01 67 00.2

METEOROLOGICAL AND SEISMIC DESIGN CRITERIA

1. SCOPE. Buildings, non-structural components and non-building structures shall be designed in accordance with this section. In the event of conflict with requirements in other sections, the more stringent criteria shall be followed.

2. DESIGN CRITERIA. Buildings, non-structural components, non-building structures including anchorage of such items, shall be designed in accordance with the following criteria.

General Design Data:

Building code and references	CBC 2016, ASCE 7-10 “Minimum Design Loads for Buildings and Other Structures”, AISC 360 “Specification for Structural Steel Buildings”, AISC 341 “Seismic Provisions for Structural Steel Buildings”
Site elevation, above mean sea level (ft)	75 to 135
Design flood elevation, DFE (ft)	Not within WRF boundary
Design groundwater elevation (ft below surface)	13 to 18
Minimum ambient air temperature, °F	23.1
Maximum ambient air temperature, °F	110.6

Wind Design Data:

Ultimate design wind speed, V_{ult} (mph)	115
Nominal design wind speed, V_{asd} (mph)	89
Exposure category	C
Risk Category	III

Building enclosure classification	Enclosure classification to be determined by building manufacturer in accordance with the current edition of ASCE 7 Chapter 26, Section 26.2.
Seismic Design Data	
Mapped MCE short period spectral response acceleration, S_S	1.135
Mapped MCE one second period spectral response acceleration, S_1	0.421
Design short period spectral response acceleration, S_{DS}	0.757
Design one second period spectral response acceleration, S_{D1}	0.387
Risk Category	III
Building Importance factor, I	1.25
Building Seismic Design Category	D
Non-Structural Components Importance factors, I_P	As indicated in the Non-Structural Component Schedule
Non-Structural Components Seismic Design Category	D
Non-Builidng Structures Importance factors, I	As indicated in the Non-Building Structure Schedule or in the applicable reference documents, whichever is greater.

3. WIND ANCHORAGE. Equipment that is to be located outdoors shall have anchor bolts designed for the effects of wind forces, as determined in accordance with ASCE 7, Chapters 26-31. Design of anchorage into concrete shall be in accordance with ACI 318 Chapter 17, shall consider concrete to be cracked, and shall not include the strengthening effects of supplementary reinforcement or anchor reinforcement unless approved by the Structural Engineer of Record. Design of anchorage into masonry shall be in accordance with ACI 530. Post-installed anchors into concrete or masonry may be used only when approved by the Structural Engineer of Record, and shall be designed in accordance with the anchor manufacturer's research report. Shop drawings shall include full anchor bolt details, and shall be sealed by a professional engineer licensed in the state

of the project. Calculations shall be furnished when requested by the Structural Engineer of Record.

4. SEISMIC DESIGN.

4-1. General. Structural systems shall provide continuous load paths, with adequate strength and stiffness to transfer all seismic forces from the point of application to the point of final resistance.

4-2. Pre-Engineered Buildings. Pre-engineered buildings shall have sufficient strength and ductility to resist the specified seismic effects defined for buildings and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code.

"W" for buildings shall include the total dead load, the total operating weight of permanent equipment and the effective contents of vessels, and applicable portions of other loads, as required by the specified building code.

4-3. Non-Structural Components. Non-structural components are architectural, mechanical, and electrical items that are permanently attached to and supported by a structure but are not part of the structural system, as indicated in Chapter 13 of ASCE 7. The Non-Structural Components Schedule identifies the components that require seismic design. The requirements of this paragraph are applicable only to the items listed in the Non-Structural Components Schedule.

4-3.01. General. Design of non-structural components shall be in accordance with all applicable provisions of ASCE 7, Chapter 13. "W_p" shall include the total operating weight of the component or system, including, but not limited to, any insulation, fluids, and concentrated loads such as valves, condensate traps, and similar components.

4-3.02. Anchorage Design. Every component in the Non-Structural Components Schedule shall have its anchorage to the supporting structure designed in accordance with ASCE 7, Chapter 13. Design of anchorage into concrete shall be in accordance with ACI 318 Chapter 17, shall consider concrete to be cracked, and shall not include the strengthening effects of supplementary reinforcement or anchor reinforcement unless approved by the Structural Engineer of Record. Design of anchorage to concrete shall also include the overstrength factors indicated in ASCE 7, Tables 13.5-1 and 13.6-1. Design of anchorage into masonry shall be in accordance with ACI 530. Post-installed anchors into concrete or masonry may be used only when approved by the Structural Engineer of Record, and shall be designed in accordance with the anchor manufacturer's research report.

Components shall be attached so that seismic forces are transferred to the structural system. Curbs that support roof-mounted equipment shall be designed to transfer forces from the equipment into the main structural roof members. All structural attachments shall be bolted, welded, or otherwise positively fastened. Frictional resistance due to gravity shall not be considered in evaluating the required resistance to seismic forces.

4-3.03. Component Design. Components indicated in the Non-Structural Components Schedule to require design of the component itself, as opposed to an anchorage design alone, shall be designed in accordance with ASCE 7, Chapter 13.

Components shall have sufficient strength and ductility to resist the specified seismic effects, and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code and other referenced codes. Components shall be designed to be operable during and following a design level seismic event without collapsing, breaking away from supports, creating an ignition hazard, or releasing any contents.

Seismic effects that shall be analyzed in the design of piping systems include the dynamic effects of the piping system, contents, and supports. The interaction between piping systems and the supporting structures, including other mechanical and electrical equipment, shall also be considered. Where pipe supports are to be designed by system supplier and/or vendor, as required by the Pipe Supports section, both the piping and support systems shall be designed to meet the applicable requirements of ASCE 7, Chapter 13.

4-3.04. Submerged Components. Components that are to be submerged in water shall be designed to withstand loads from the effects of water sloshing during the seismic event. The calculation of the sloshing effects shall be in accordance with the latest edition of ACI 350.3.

4-3.05. Seismic Certification. Design of components and their anchorage shall be certified by one of the following methods.

1. Analysis and design by a design professional registered in the state of the project.

2. Shake table testing based upon a nationally recognized testing standard procedure, such as ICC-ES AC 156, acceptable to the authority having jurisdiction.

3. Experience data, based upon nationally recognized procedures acceptable to the authority having jurisdiction.

Components indicated in the Non-Structural Components Schedule to require special seismic certification shall be certified only by methods 2 or 3 above, except that certification for containment of hazardous materials may be by any of the three methods.

4-3.06. Construction Documents. Construction documents (fabrication or shop drawings) of non-structural components and anchorage design shall be sealed by a design professional that is registered in the state of California. Documents shall be sealed whether the basis for certification is analysis and design, shake table testing, or experience data. The sealing method shall clearly indicate that the anchorage system, and the component itself when applicable, have been designed for the code required seismic forces.

4-3.07. Submittals. The construction documents, structural design calculations, shake table certification, and experience data certification, as applicable, shall be submitted in accordance with the Submittal Procedures section.

4-4. Non-Building Structures. Non-building structures are the items described as such in Chapter 15 of ASCE 7. The Non-Building Structures Schedule identifies the items that require seismic design. The requirements of this paragraph are applicable only to the items listed in the Non-Builiding Structures Schedule.

4-4.01. General. Design of non-building structures shall be in accordance with all applicable provisions of ASCE 7, Chapter 15. Design of anchorage into concrete shall be in accordance with ACI 318 Chapter 17, shall consider concrete to be cracked, and shall not include the strengthening effects of supplementary reinforcement or anchor reinforcement unless approved by Design-Builder. Post-installed anchors into concrete may be used only when approved by Design-Builder, and shall be designed in accordance with the anchor manufacturer’s research report.

"W" shall include the total dead load and shall also include all normal operating contents of tanks, vessels, bins, and piping.

Non-building structures shall provide sufficient strength and ductility to resist the specified seismic effects, and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code and other referenced codes.

The seismic design of non-building structures shall provide sufficient stiffness, strength and ductility to resist the effects of seismic ground motions during the design level earthquake.

Non-building structures shall be designed to be operable during and following a design level seismic event, without collapsing, breaking away from supports, creating an ignition hazard, or releasing any contents.

4-4.02. Construction Documents. Construction documents (fabrication or shop drawings) depicting all seismic force resisting elements of non-building structures shall be sealed by a design professional that is registered in the state of the project.

4-4.03. Submittals. The construction documents shall be submitted in accordance with the Submittal Procedures section.

End of Section

Non-Structural Components Schedule					
Component		Applicable Specification Section	Importance Factor (I_p)	Component Design Required	Special Seismic Certification Required
Metal Partition Walls		05 40 00	1.5		
Weir Plates and Scum Baffles		06 82 00	1.0		
Odor Control Covers		06 82 00	1.0		
Steel Doors and Frames		08 11 14			
Overhead Coiling Steel and Fire Doors		08 33 23.23			
Aluminum Entrances and Assemblies		08 41 14			
Aluminum Windows		08 51 13			
Glass Glazing		08 81 00			
Acoustical Panel Ceilings		09 51 13			
Plastic Toilet Compartments		10 21 13.19			
Louvers and Vents		08 90 00			
Metal Lockers		10 51 13			
Horizontal End Suction Centrifugal Pumps		43 21 13.13	1.0		
Submersible Pumps		43 21 39.11	1.0		
Horizontal Submersible Propeller Pumps		43 21 39.23	1.0		
Rotary Lobe Pumps		43 23 58	1.0		
Mechanically Cleaned Bar Screens		46 21 12	1.0		
Vortex Grit Removal Equipment		46 22 23	1.0		
Grit Separation and Classification Equipment		46 22 64	1.0		
Packaged Odor Control System		44 31 19	1.0		
Odor Control Fans		43 11 21	1.0		
Submersible Mixers		46 41 23	1.0		
Fine Pore Diffused Aeration Equipment		46 51 31	1.0		
Coarse Bubble Diffusers		46 51 21	1.0		
Rotary Positive Displacement Blowers		43 11 17	1.0		
Dry Screw Positive Displacement Blower		43 11 15	1.0		
Compressed Air Equipment – Base Mounted Compressors		43 12 32	1.0		
Rotary Screw Air Compressors		43 12 24	1.0		
Engine Generators		26 32 13	1.5	x	x
Laboratory Furniture		12 56 53			
MBR		46 61 35	1.0		

Non-Structural Components Schedule					
Component		Applicable Specification Section	Importance Factor (I_p)	Component Design Required	Special Seismic Certification Required
Low Pressure Reverse Osmosis/Nano Filtration Equipment		46 63 25	1.0		
Fiberglass Reinforced Plastic Chemical Storage Tanks		43 41 45.13	1.5	x	x
Ammonia Storage Tanks		43 42 22	1.5	x	x
Aboveground Fuel Storage Tanks		33 56 13	1.5	x	x
Panels, Consoles, and Appurtenances		40 67 00	1.0		
Fire Sprinkler Systems		21 13 00	1.5	x	
Screw Conveyors		41 12 13.36	1.0		
Traveling Bridge Cranes		41 22 13.13	1.0		
Piping Systems and Related Pipe Supports		40 05 07.13			
All above ground pipes.			1.0		
Plumbing		22 00 00	1.0		
Water Heaters		22 00 00	1.0		
HVAC Equipment		23 00 00	1.0		
Gas Vent Systems		23 00 00	1.0		
Air-Side HVAC Air Handling Units, Furnaces, Makeup Air Units, Fans, Heaters, and Other Mechanical Components Constructed of Sheet Metal Framing		23 00 00	1.0		
Ductwork Including Inline Components		23 00 00	1.0		
Wet-Side HVAC Air Separators, Chemical Feed Pots, Expansion Tanks, Pumps, and Other Mechanical Components Constructed of High-Deformability Materials		23 21 11	1.0		
Piping, Tubing, and Inline Components		23 21 11	1.0		
Heating Systems Equipment		23 50 13	1.0		
Heaters, and Other Mechanical Components Constructed of Sheet Metal Framing		23 50 13	1.0		
Wet-Side HVAC Boilers and Other Mechanical Components Constructed of High-Deformability Materials		23 50 13	1.0		
Refrigeration Systems		23 70 00	1.0		
Condensing Units, Heat Pumps, Packaged Air Conditioning Units and Heat Pumps and Other Mechanical Components Constructed of Sheet Metal Framing		23 70 00	1.0		

Non-Structural Components Schedule					
Component		Applicable Specification Section	Importance Factor (I_p)	Component Design Required	Special Seismic Certification Required
Wet-Side HVAC Chillers and Other Mechanical Components Constructed of High-Deformability Materials		23 70 00	1.0		
Dehumidification Systems		23 84 21	1.0		
Air Distribution Systems		23 30 13	1.0		
Air-Side HVAC Air Handling Units, Furnaces, Makeup Air Units, Fans, Air Distribution Boxes, and Other Mechanical Components Constructed of Sheet Metal Framing		23 30 13	1.0		
Ductwork Including Inline Components		23 30 13	1.0		
Lighting Fixtures		26 05 11	1.0		
Lighting Panels		26 05 11	1.0		
Power Panels		26 05 11	1.0		
Surge Protection Device		26 05 11	1.0		
Separately Enclosed Motor Starters		26 05 11	1.0		
Separately Enclosed Manual Starters		26 05 11	1.0		
Control Stations		26 05 11	1.0		
Separately Enclosed Circuit Breakers		26 05 11	1.0		
Disconnect Switches		26 05 11	1.0		
Lighting and Auxiliary Power Transformers		26 05 11	1.0		
Power Centers		26 05 11	1.0		
Power Factor Correction Capacitors		26 05 11	1.0		
Lighting Contactors		26 05 11	1.0		
Photoelectric Controls		26 05 11	1.0		
Relay Enclosures		26 05 11	1.0		
Alarm Horn and Beacon		26 05 11	1.0		
Adjustable Frequency Drives		26 29 24	1.0		
Common Motor Requirements for Process Equipment		40 05 93	1.0		
Low Voltage Switchgear		26 23 00	1.0		
Switchboards		26 24 13	1.0		
600 Volt Class Motor Control Centers		26 24 23	1.0		
Bypass Isolation Automatic Transfer Switch		26 36 26	1.0		
Lightning Protection Systems		26 41 13	1.0		

Non-Structural Components Schedule					
Component		Applicable Specification Section	Importance Factor (I_p)	Component Design Required	Special Seismic Certification Required
Fire Detection and Alarm Systems		28 31 16	1.5	x	
Fire Detection and Signaling System		28 31 19	1.5	x	

Note: Some specification sections listed in the Non-Structural Components Schedule cover multiple items. Within those sections, some components may be exempt from seismic design based on their weight and/or their height above the floor. Reference ASCE 7, Paragraph 13.1.4 for specific conditions of the exemptions. Some ductwork and piping systems may also be exempt from seismic design based on criteria in their respective paragraphs in ASCE 7, Chapter 13.

Non-Building Structures Schedule			
Structure		Applicable Specification Section	Importance Factor (I)
Steel Water Storage Reservoir		33 16 13.13	1.25

Section 01 68 00

EQUIPMENT AND VALVE IDENTIFICATION

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and installation of nameplates and tags for identification of equipment, valves, panels, and instruments.

1-2. GENERAL. Except as otherwise specified in equipment, valve, and instrumentation sections, nameplates and tags shall be as specified herein. Nameplates or tags shall be provided for all equipment, valves, operator interfaces, control and electrical panels, cabinets, instruments, and instrument racks that have been named and/or tagged on the Drawings.

1-3. SUBMITTALS. Drawings and data shall be submitted in accordance with the requirements of the Submittals Procedures section for each type of tag provided including materials, colors, sizes, letter sizes, and installation instructions.

PART 2 - PRODUCTS

2-1. EQUIPMENT NUMBER PLATES. All equipment tagged on the drawings, shall be provided with number plates bearing the equipment tag number identified on the Drawings. Number plates shall be bevelled, 1/8th inch thick laminated black phenolic plastic engraving stock with white core. Lettering on number plates shall be capitalized block letters ¾ inch high. Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered, unless approved otherwise by the Design-Builder.

Number plates shall be attached with stainless steel panhead screws, rivets, or drive screws.

When a number plate cannot be installed due to the physical size, space, or mounting surface geometry of the equipment, the Contractor shall provide a 12 gauge stainless steel tag with engraved or imprinted equipment tag number. Lettering on tags shall be ¼ inch high. Tags shall be rectangular with smooth edges and shall be fastened to the equipment with stainless steel mechanical fasteners or with a stainless steel chain.

2-2. EQUIPMENT INFORMATION PLATES. Equipment shall be provided with engraved or stamped equipment information plates securely affixed with mechanical fasteners to the equipment in an accessible and visible location. Equipment information plates shall be in addition to the number plates specified. Equipment information plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment information plates listing the distributing agent only will not be acceptable.

2-3. VALVE AND GATE TAGS.

2-3.01. Temporary Tags. Each valve and gate with an identifying number indicated on the Drawings or listed in the valve or gate schedule, shall be tagged or marked in the factory with the identifying number.

2-3.02. Permanent Tags. All valves and gates, unless it is buried or less than two inches, that have been assigned a number on the Drawings or in the valve or gate schedule, shall be provided with a permanent number plate. Tags shall be permanently attached to valves and gates with stainless steel wires. Numerals shall be ¾ inch high and shall be black baked enamel on an anodized aluminum plate or 316 stainless steel, unless otherwise approved by the Design-Builder.

2-4. PANEL NAMEPLATES. Nameplates shall be provided on the face of each panel and cabinet. Panel identification nameplates shall be mounted at the top of the panel shall include the panel descriptive name and tag number as indicated on the Drawings, in two or three lines of text. Lettering shall be ¾ inch high.

Nameplates for devices mounted on or in the panel shall be inscribed with the text as indicated on the Drawings. Where nameplate information is not indicated on the Drawings, inscriptions shall be in accordance with information in the supplier's submittal drawings as guided by information in the relevant specification section. Panel device nameplates shall have engraved letters 3/16 inch high, unless otherwise approved by the Design-Builder.

Nameplate material and size shall be as specified above for equipment number plates. Nameplates shall be secured to the panel with stainless steel panhead screws.

2-5. INSTRUMENT TAGS.

2-5.01. Temporary Tags. Where instruments are not provided with permanent tags furnished from the factory, instruments shall be tagged or marked in the factory with the instrument tag number indicated on the Drawings.

2-5.02. Permanent Tags. Instruments shall be tagged with the instrument tag number indicated on the Drawings. Tags shall be 12 gauge stainless steel with engraved or imprinted symbols. Lettering on tags shall be ¼ inch high. Tags shall be rectangular with smooth edges, and shall be fastened to the instrument with stainless steel mechanical fasteners or with a stainless steel chain, unless otherwise approved by the Design-Builder.

PART 3 – EXECUTION

Not used.

End of Section

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Section 01 73 19

EQUIPMENT INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers general installation requirements of new equipment units that have been purchased by Design-Builder as part of this Work. Equipment specific installation requirements are covered in the equipment sections.

1-2. GENERAL. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. Coordination. When manufacturer's field services are provided by the equipment manufacturer, Design-Builder shall coordinate the services with the equipment manufacturer.

Flanged connections to equipment including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section.

PART 2 - PRODUCTS

2-1. MATERIALS. Materials shall be as follows:

Grout	As specified in the Grouting section.
Anti-Seize thread lubricant for SS bolts	As specified in the Anchorage in Concrete and Masonry section.

PART 3 - EXECUTION

3-1. INSTALLATION. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results as specified in the Startup Requirements section.

Each equipment unit shall be leveled, aligned, and shimmed into position. Installation procedures shall be as recommended by the equipment manufacturer and as required herein. Shimming between machined surfaces will not be permitted.

Anti-seize thread lubricant shall be liberally applied to the threaded portion of all stainless steel bolts during assembly. For equipment installed in drinking water facilities, the anti-seize lubricant shall meet requirements of NSF-61.

When specified in the equipment sections, the equipment manufacturer will provide installation supervision and installation checks. For installation supervision, the manufacturer's field representative will observe, instruct, guide, and direct Design-Builder's erection or installation procedures as specified in the equipment specifications. For installation checks, the manufacturer's field representative will inspect the equipment installation immediately following installation by Design-Builder, and observe the tests indicated in the Startup Requirements section. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

All equipment shall be protected after installation, prior to final acceptance by Owner. Protection provisions shall be as recommended by the manufacturer, and shall include provisions to prevent rust, mechanical damage, and foreign objects entering the equipment.

3-2. STARTUP AND TESTING. Startup requirements, and tests associated with startup shall be as indicated in the Startup Requirements section. Other field tests shall be as indicated in the specific equipment sections. Startup and tests required shall occur in the order listed in the following paragraphs. Tests shall not begin until any installation supervision and installation checks by the equipment manufacturer have been completed, except where noted below.

3-2.01. Preliminary Field Tests. Preliminary field tests shall be conducted on all equipment by Design-Builder as indicated in the Startup Requirements section. When an installation check is specified in the equipment sections, the equipment manufacturer's representative will participate in these tests to the extent described in the Startup Requirements section and in the equipment sections.

3-2.02. Field System Operation Tests. Field system operation tests shall be conducted on all equipment by Design-Builder as indicated in the Startup Requirements section. When an installation check is specified in the equipment sections, the equipment manufacturer's service personnel will participate in these tests to the extent described in the Startup Requirements section and in the equipment sections.

3-2.03. Field Demonstration Tests. Field demonstration tests will be conducted by the equipment manufacturer on equipment as indicated and as specified in the equipment sections.

3-2.04. Field Performance Tests & Distribution Tests. Field performance tests or distribution tests will be conducted by the equipment manufacturer on equipment as indicated and as specified in the equipment sections.

3-2.05. Field Baseline Performance Tests. Field baseline performance tests shall be conducted by Design-Builder on the equipment indicated in the equipment sections, and the tests shall be performed as indicated. When indicated in the equipment sections, the equipment manufacturer will participate in these tests. This test shall not be considered an acceptance test, but rather a test to determine initial performance curves and efficiency just prior to the equipment entering service.

End of Section

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Section 01 79 00

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 DESCRIPTION. This section contains requirements for training the Owner's personnel in the proper operation and maintenance of the equipment and systems installed under this contract. Additional training requirements may be provided in individual specification sections.

1.02 GENERAL. Where indicated in the specifications, the manufacturer's representative shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS. The following information shall be submitted to the Design-Builder in accordance with the provisions of the Submittal Procedures section. The material shall be submitted not less than 8 weeks prior to the provision of training, unless otherwise approved by the Design-Builder.

1. Lesson plans, training manuals, handouts, visual aids, and other reference materials for each training session to be conducted by the manufacturer's representatives.
2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 – PRODUCTS

2.01 GENERAL. Where specified, the Supplier shall conduct training sessions for the Owner's personnel to instruct staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 90 days prior to the date schedule for the individual training session, unless otherwise approved by the Design-Builder.

2.02 LOCATION. Training sessions shall take place at the site of the work at a location designated by the Owner.

2.03 TIMING. The training of the Owner's personnel shall be at such times as requested by the Owner.

2.04 LESSON PLANS. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of the visual aids to be utilized during the sessions. Each plan shall contain time allocation for each subject.

One complete set of originals of the lesson plans, training manuals, handouts, visual aids and reference materials shall be the property of the Owner and shall be suitable bound for proper organization and easy reproduction. The Supplier shall furnish ten copies of necessary training manuals, handouts, visual aids, and reference materials at least 1 week prior to each training session.

2.05 FORMAT AND CONTENT. Each training session shall include classroom and time at the location of the subject equipment or system. As a minimum, training sessions shall cover the following subjects for each item of equipment or system:

1. Familiarization:
   a. Review catalog, parts lists, drawings, etc, which have been previously provided for the plan files and operation and maintenance manuals.
   b. Guided inspection of the subject equipment.
   c. Demonstration of the subject equipment and how operation in accordance with the specified requirements.

2. Safety:
   a. Review and demonstration of safety procedures and related documentation.
   b. Inspection and discussion of hazardous components of the subject equipment.

3. Operation:
   a. Review of subject equipment operations literature and theory of operation.
   b. Overview of equipment operation and function.
   c. Explanation and demonstration of all modes of operation including start up, shut down, normal, and emergency operation, and manual and automatic operation through the plant control system.
   d. Explanation of all hardwired interlocks.
   e. Explanation and demonstration of equipment related valves and their purpose.
   f. Explanation of all equipment related instruments including primary element, instrument indicator, purpose, and interpretation of information.
   g. Check out of Owner's personnel on proper use of the equipment.

4. Preventive Maintenance:
    a. Review preventative maintenance documentation and discussion of maintenance require at various intervals; e.g. daily, weekly, monthly, annually.
    b. Demonstrate performance of each preventive maintenance task.
    c. Identification of indicators of equipment problems.
    d. Discussion of corrosion protection and lubrication requirements.
    e. Requirements for periodic exercise of equipment and demonstration of equipment exercise where required.
    f. Identification of inspection points and demonstration of inspection covers removal and routine disassembly and assembly of equipment.

5. Corrective Maintenance and Equipment Repair:
    a. Discussion of common repairs and identification of special problems.
    b. Explanation and demonstration of equipment inspection and troubleshooting.
    c. Demonstration of calibration procedures.
    d. Demonstration of repair procedures where practical.

6. Parts:
    a. Discussion of the parts list and ordering of parts.
    b. Review of spare parts provided with the equipment and identification of other recommended spare part.

7. Local Representatives:
    a. Name, address, telephone of local representative.
    b. Review of contact information for providers of routine and emergency repair and operational assistance.

8. Operation and Maintenance Manuals.

Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled so that training is performed when equipment is available for operation. The Design-Builder shall arrange to have the training conducted on consecutive days, with no more than 6 hours of class scheduled for any one day. Concurrent classes will not be permitted.

Additional training requirements specific to various equipment may be provided in the separate technical specifications.

End of Section

Section 03 01 26.66

CONCRETE CRACK REPAIR

PART 1 - GENERAL

1-1. SCOPE. This section covers the repair of concrete and shotcrete cracks and joints.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-1.01. General Crack Repair. General crack repair is applicable only to new construction, and shall include the following:

a. Sealing of all cracks and crack networks that are wider than 10 mils (0.01 inch) [250 µm] as measured at the exposed surface.

b. All necessary repairs to structures that have failed a tightness test, including sealing of construction joints.

1-1.02. Engineer-Directed Crack Repair. Engineer-directed crack repair is applicable only to new construction, and shall only be performed when instructed by the Structural Engineer of Record. The work shall include, but is not limited to, the following:

a. Sealing of construction joints that are not otherwise required to be sealed as the result of a failure of a leakage test.

b. Sealing of cracks and crack networks with a width of 10 mils (0.01 inch) [250 µm] or less as measured at the exposed surface.

The crack repair may be either epoxy resin or foam resin, as determined by the Structural Engineer of Record.

1-1.03. Pre-Defined Crack Repair. Pre-defined crack repair is applicable only to existing structures, and the extent of this type of repair is indicated on the Drawings.

Prior to beginning the repair work Design-Builder shall field verify and provide clear bright colored marking to the cracks to be repaired. Crack repair work shall not begin until marking is complete and has been approved by the Structural Engineer of Record.

1-2. SUBMITTALS. Specifications and data covering physical properties, mixtures, application procedures, and curing procedures of the materials proposed shall be submitted in accordance with the Submittals Procedures section. Submittals shall include the approvals from the material manufacturer.

1-3. QUALITY ASSURANCE.

1-3.01. Manufacturer's Field Services. The material manufacturer shall provide engineering field services to review the Work and the material application prior to any preparation; to approve the applicator, the material used, and the procedure to be used; to observe surface preparation; to approve surface preparation; and to observe application. The field representative of the material manufacturer shall submit, in writing through Design-Builder, approvals of proposed material, application procedures, applicator, and surface preparation. The field representative shall be an employee of the material manufacturer.

1-3.02. Applicator. The applicator shall submit through Design-Builder a satisfactory experience record including references from previous application of the specified materials to structures of similar design and complexity.

1-3.03. Pre-Construction Meeting. At least 30 days prior to concrete crack repairs, Design-Builder shall conduct a meeting to review the detailed requirements for rehabilitation work. Site conditions, surface preparation, proposed equipment, procedures, material mixing, placing procedures, and curing methods shall be discussed and approved by the Structural Engineer of Record and by the manufacturer's field representative. Design-Builder shall require the attendance of all involved parties, including but not limited to Design-Builder's superintendent, repair contractor, manufacturer's field representative and proposed equipment supplier representative. Minutes of the meeting shall be recorded, typed and printed by Design-Builder and distributed to all parties within 5 days after the meeting.

1-3.04. Quality Assurance Certification. Material manufacturers shall be ISO 9001/9002 registered or shall provide proof of documented quality assurance. The documented quality assurance system shall be obtained through an independent auditing registrar.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Unless otherwise specified or authorized, repairs shall conform to the requirements specified herein. Types of repairs not specified herein shall be as specified in other sections, as indicated on the Drawings, or, in the absence of any definite requirement, as recommended by the manufacturer's representative and subject to acceptance by the Structural Engineer of Record. The following types of repairs shall be performed as required.

2-1.01. Pressure-Injected Epoxy Resin. Unless indicated otherwise on the drawings, pressure-injected epoxy resin shall be used to seal joints and cracks that are not intended to permit movement.

2-1.02. Pressure-Injected Foam Resin. Unless indicated otherwise on the drawings, pressure-injected foam resin shall be used to seal joints that are intended to permit movement.

2-1.03. Crack Sealant. Crack sealant shall be used to seal cracks in structures prior to pressure injection of resin.

2-2. ACCEPTABLE PRODUCTS. Repair products/materials shall be as specified herein. Equivalent products of other manufacturers regularly producing high quality concrete crack repair products/materials, providing engineering field services, and meeting the specified quality assurance requirements may be furnished subject to review and acceptance by the Structural Engineer of Record.

2-3. MATERIALS. Materials shall be approved by the manufacturer for the type of application, including temperature and moisture conditions encountered.

Pressure-Injected Epoxy Resin	ASTM C881, Type I or Type IV, moisture tolerant or moisture insensitive.
Crack Sealant	As recommended by the manufacturer of the pressure-injected epoxy resin product.
Pressure-Injected Foam Resin	Hydrophilic polyurethane foam; Prime Resins “Prime-Flex 900 XLV”, DeNeef "Sealfoam PURe", or Avanti “AV-333 Injectaflex”.
Foam Resin Accelerator	As recommended by foam resin manufacturer.
Water	Clean and free from deleterious substances.

PART 3 - EXECUTION

3-1. INSPECTION. Prior to the placement of the repair materials, the crack to be repaired shall be inspected by the material manufacturer to assure that preparation and conditions are correct for the type of repair and the product/material being used as specified herein.

3-2. PREPARATION. All cracks and surfaces around the cracks shall be free of objectionable substances and shall conform to the requirements of the material manufacturer. Concrete and shotcrete to be repaired shall be cleaned by methods acceptable to the material manufacturer so that the cracks are free of dirt, oil, grease, laitance, and other foreign matter. All loose and deteriorated existing concrete and shotcrete shall be removed down to sound materials. All concrete and shotcrete surfaces shall be checked for delamination to ensure that all surfaces are sound. All edges shall be square cut to avoid feather edges.

Any other preparation recommended by the material manufacturer shall be brought to the Structural Engineer of Record's attention and may be incorporated into the work if acceptable.

Concrete and shotcrete surfaces in the area of a crack to be repaired shall be cleaned by wire brushing, blasting, or other acceptable methods.

Wall surfaces shall be sandblasted clean to expose crack networks and construction joints. If there is active water seepage in the repair area, the seepage shall be stopped as recommended by the injection material manufacturer and as acceptable to the Structural Engineer of Record. Injection ports shall be installed, when recommended by the injection material manufacturer.

3-2.01. Injected Epoxy Resin. Preparation for injected epoxy resin shall include sealing the surface at the crack, on both sides when possible, with crack sealant as recommended by the material manufacturer and as acceptable to the Structural Engineer of Record for the pressure injection work. Injection ports for epoxy resin shall penetrate through the crack sealant into the cracks at spacings recommended by the material manufacturer.

3-2.02. Injected Foam Resin. Preparation for injected foam resin shall include drilling offset injection holes at an angle that will intersect the crack, joint, or crack network at approximately one-half the thickness of the concrete or shotcrete up to a thickness of 36 inches [900 mm]. Spacing of injection ports shall be determined as recommended by the injection material manufacturer and as acceptable to the Structural Engineer of Record. When the injection material manufacturer certifies, in writing, that spacing of injection ports and installation procedures are acceptable, the injection ports may be installed directly into the crack, subject to review by the Structural Engineer of Record.

3-3. APPLICATION. Concrete and shotcrete repair work shall be performed in accordance with the following requirements.

3-3.01. Crack Sealant. Crack sealant shall be trowel-applied to a minimum dried thickness of 1/8 inch [3 mm], or thicker if directed by manufacturer's literature. The concrete surface where the sealant is applied shall be smooth, uniform, and free from irregularities. Crack sealant shall be removed after the injection of resin is completed, except for portions of wall faces that will be at least 12 inches below the finished grade.

3-3.02. Pressure-Injected Resin. The injected areas shall be prepared as specified and as recommended by the manufacturer. Pressure-injected resin shall be suitable for penetration of joints, cracks, and crack networks 2 mils (0.002 inch) [50 µm] wide and larger.

After the joints and cracks are prepared and before the injection of the resin, the joints shall be flushed with water. The water flush shall be terminated when the turbidity of the expelled water is equal to that of the flush water. Unless otherwise acceptable to resin manufacturer and Structural Engineer of Record, cracks shall be dry prior to injecting resin.

The pumping equipment used for the pressure injection of resin shall have pressure metering. Written procedures for use and quality control of the injection equipment shall be furnished to the Structural Engineer of Record for review and acceptance. The pump shall be electric. The material and process used for the pressure injection of the resin shall have been in use a minimum of 5 years.

The joints and crack networks shall have a minimum of 90 percent penetration of resin into the joint or crack network. Core samples may be taken at the Structural Engineer of Record's discretion.

3-3.02.01. Epoxy Resin. Epoxy resin shall be injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to the Structural Engineer of Record. Epoxy resin shall be injected until the resin appears at the next injection port.

3-3.02.02. Foam Resin. Foam resin shall be premixed and injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to the Structural Engineer of Record. Foam resin shall be injected into the structure until the resin appears at the next injection port.

Surfaces of cracks and joints may need to be sealed with crack sealant.

3-3.03. Cold Weather. When ambient temperatures below 40°F [4°C] are expected during the curing period, the repair materials shall be maintained at a temperature of at least 50°F [10°C] for 14 days or 75°F [24°C] for 7 days after placement. Sudden cooling of the repair materials shall not be permitted.

3-4. PROTECTION. Post-placement curing and protection shall be as specified herein and in accordance with the manufacturer's recommendations.

3-5. CLEANING. Work areas shall be cleaned each day in accordance with the Project Requirements section. Upon completion of the final cleanup, Design-Builder shall restore all areas affected by the grouting procedures to their original condition, leaving no trace of material piles or other wasted materials.

End of Section

Section 03 08 13

TIGHTNESS TESTING OF STRUCTURES

PART 1 - GENERAL

1-1. SCOPE. This section covers hydrostatic tightness testing of concrete structures.

Tightness testing, cleaning, and disinfection of steel storage reservoirs and tanks, elevated steel tanks, and piping systems are covered in other sections.

1-2. GENERAL. Unless otherwise specified, testing shall be completed after the entire concrete structure has been constructed, cured, and has attained its design strength, but prior to placement of backfill, cleaning and disinfection, and prior to the installation of equipment in the structure.

All testing work shall be performed by Design-Builder.

1-2.01. Testing Schedule and Procedure. A testing schedule and procedure shall be prepared by the Design-Builder prior to commencement of testing. The schedule shall indicate the proposed time and sequence of testing for each structure. The procedure shall indicate the limits of the area to be tested, define the method of isolation, the position and use of valves during testing, the location of temporary bulkheads, the process for introducing water and air into the structure, the method of measuring water and air losses, any correction methods required due to evaporation and precipitation, the method and location for disposal of testing water, and any other activities relevant to the testing.

Design-Builder shall notify Owner's Representative at least five days in advance of the time that testing of any individual structure will begin.

1-2.02. Water. Water used for testing shall be conserved through collection and reuse in subsequent tests. Following completion of testing work, the water shall be disposed of in a manner acceptable to Owner and shall not be allowed to enter other parts of the system.

PART 2 - PRODUCTS

2-1. TEST EQUIPMENT. All necessary connections between the structure to be tested and the water source or other test medium, together with pumping equipment, any necessary metering devices, pressure or vacuum gauges, and all other equipment, materials, and facilities required to perform the specified tests and dispose of the test medium after completion of testing, shall be provided by

Design-Builder. Design-Builder shall provide all required temporary flanges, valves, bulkheads, bracing, blocking, and other sectionalizing devices that may be necessary to perform the testing. All temporary devices shall be removed upon satisfactory completion of testing.

2-2. STRUCTURES TO BE TESTED. The structures to be tested are indicated in the Tightness Testing of Structures schedule.

2-3. ALLOWABLE WATER LOSS. The maximum allowable water loss and the test duration shall be as specified in the Tightness Testing of Structures schedule.

Adjustments for evaporation and precipitation shall be required when indicated in the schedule. A partially filled plastic pan or tub having dimensions proportionately similar to those of the basin shall be placed in the basin and monitored to account for evaporation or rainfall.

Each leak which is discovered during the correction period shall be located and repaired.

PART 3 - EXECUTION

3-1. HYDROSTATIC TEST PROCEDURES. The hydrostatic test shall consist of both a visual inspection and a water loss measurement.

Unless otherwise specified, tightness testing shall be performed after all pipe sleeves have been installed but before backfilling or the interior waterproofing material or coating has been applied or exterior dampproofing material has been applied.

Paint that has been applied to piping, valves, or other items shall be permitted to dry in accordance with the paint manufacturer’s instructions prior to introducing test water into the tank.

Exposed concrete surfaces of the structure, including the floor, shall be cleaned of all foreign material and debris prior to the test. Standing water in or outside the structure that would interfere with observation of the exposed concrete surfaces shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired prior to filling the tank with water.

Adjacent structures having common walls shall be tested individually at different times to permit examination of the dividing walls for leaks.

Pipe connections or openings to structures, if not provided with drip tight valves, shall be temporarily plugged during testing. Where slide gates, sluice gates or similar devices are located, Design-Builder shall provide bulkheads or the means to make them drip tight, and measure any leakage.

Unless otherwise specified, each structure to be tested shall be filled with water at a uniform rate not to exceed a depth of 4 feet per hour to the level specified in the Tightness Testing of Structures schedule. The water shall be allowed to stand for at least three days prior to tightness testing in order to stabilize the absorption rate of the concrete and the water temperature. During this period, sufficient water shall be added to maintain the water level to the elevation specified.

3-1.01. Visual Inspection. All structures to be tested shall be free from visible leaks. Damp spots on exterior wall surfaces shall be considered visible leaks if moisture can be picked up on a dry hand. Damp spots on tops of wall footings will be permitted unless the water can be observed to be flowing. Repairs shall be made to visible leaks regardless of the water loss test results. All visible leaks which have not spontaneously plugged or demonstrated a definite decrease in the rate of leakage over a maximum period of 28 days shall be located and repaired by and at the expense of Design-Builder. The structure shall be retested to confirm that the repairs are satisfactory.

3-1.02. Water Loss Measurement. Measurements of water level and loss will be taken by Design-Builder each day over the test period. If the measured drop in water level, adjusted for evaporation and precipitation when applicable, exceeds the allowable amount specified in the Tightness Testing of Structure schedule and does not show a definite decreasing trend during the following 7 day period, the structure shall be drained, repaired, cleaned, refilled, and retested to the satisfaction of Engineer.

Testing shall be considered void and the basin shall be retested in the event of excessive evaporation or precipitation that results in an empty or overflowing pan.

3-1.03. Structure-Specific Requirements. Not used.

3-1.04. Disposal of Test Water. Design-Builder shall confirm that Owner intends to dispose of the test water. If the water is to be disposed of, Design-Builder shall verify there is no residual chlorine or other undesirable product in the test water to be discharged. If necessary a neutralizing chemical treatment shall be provided to condition the water prior to disposal. Design-Builder shall be responsible to determine a suitable location and method for disposing of the used test water. Water discharged to overland disposal or to a sewer system shall be discharged at flow rates and locations acceptable to the local governing agencies and in compliance with applicable rules and regulations.

3-2. PNEUMATIC TEST PROCEDURES FOR OZONE CONTACT BASINS. Not used.

3-2.01. Visual Inspection. While maintaining the pressure, the basin top slab and the walls above the water surface and the top slab, shall be visually observed for leaks. A leak detection solution shall be applied to all potential leakage areas, including the entire roof slab, and the appearance of bubbles shall be used to indicate leakage. All locations where leakage occurs shall be repaired prior to performing the pressure loss measurement.

The leak detection solution shall be a non-contaminating solution suitable for summer or winter use as appropriate. The leak detection solution for summer use shall be “Sherlock” Type CG manufactured by Winton Products Co. The leak detection solution for winter use shall be “No. OX-65-C (-65°F to +35°F)” as manufactured by American Gas and Chemicals Co.

3-2.02. Pressure Loss Measurement. After acceptance of the visual inspection, a pressure loss measurement test shall be performed. The basin shall be filled with potable water to the elevation specified for hydrostatic testing. The basin shall then be pressurized to 14 inches water column utilizing the procedure previously described.

The test duration shall be as indicated in the Tightness Testing of Structures schedule. At the end of the test period the pressure within the basin shall be recorded. The pressure loss shall not exceed the allowable pressure loss specified in the Tightness Testing of Structures schedule. If the pressure loss exceeds the allowable pressure loss, leaks shall be identified and sealed and the basin retested.

End of Section

Schedule 03 08 13-S01

TIGHTNESS TESTING OF STRUCTURES

Structure	Hydrostatic Testing			
	Water Surface Elevation	Allowable Water Surface Drop	Test Duration	Consider Evaporation and Precipitation
	ft	inches	days	(Y/N)
SAFE Box	133.96	0.60	5	N
BNR Basins Deox Box	129.00	0.48	4	Y
BNR Basins Splitter Chimney	129.00	0.48	4	Y
BNR Basins Anoxic and Aeration Zones (2 trains)	129.00	0.48	4	Y
BNR Mixed Liquor Channels (2 trains)	129.00	0.36	3	Y
MBR Cassette Tanks	130.84	0.36	3	Y
MBR RAS Channels	130.84	0.36	3	Y
Sludge Holding Tanks (2 trains)	133.00	0.36	3	Y
Chemical Containment Facility	104.00	0.125	3	Y

End of Section

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Section 03 11 00

CONCRETE FORMING

PART 1 - GENERAL

1-1. SCOPE. This section covers formwork for cast-in-place concrete.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-2. GENERAL. All forms shall be accurately and properly placed so cast-in-place concrete may be placed as indicated on the Drawings and as specified. The forms shall produce a smooth concrete finish free from offsets or irregularities.

1-3. SUBMITTALS. All submittals of catalog data sheets, manufacturers' certificates of compliance and other data shall be in accordance with the Submittals Procedures section.

PART 2 – PRODUCTS

2-1. MATERIALS.

Forms

Prefabricated	Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", or Universal "Uni-form".
Plywood	Product Standard PS1, waterproof, resin-bonded, exterior type Douglas fir, face adjacent to concrete Grade B or better.
Fiberboard	ANSI/AHA A135.4, Class 1, tempered, water-resistant, concrete form hardboard.
Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Chamfer Strips	Clear white pine, surface against concrete planed.
Form Coating	Nonstaining and nontoxic after 30 days. Product shall not exceed VOC limits established

by the federal, state, or local regulatory agency having jurisdiction over the project site.

2-2. FORMS. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the Drawings. Forms shall conform to ACI 347R and the following additional requirements.

Stay-in-place metal formwork will not be permitted.

Exception: Stay-form shall be permitted in select locations as approved by the Structural Engineer of Record.

Form-facing materials shall be selected in accordance with ACI 347.3R, based upon the applicable formed concrete surface category. Formed concrete surface categories vary by structure and application, and shall be as indicated in the Concrete Finishing section. Other types of forming materials, such as steel or unlined wood, may be used where plywood or lined forms are not required, and may be used as backing for form linings. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and concave or convex areas, within the tolerances specified herein.

All vertical concrete surfaces above footings shall be formed.

Flat segmented forms not more than 24 inches [600 mm] wide may be used for forming curved surfaces 25 feet [7600 mm] in diameter or larger.

2-2.01. Design. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that permissible working stresses are not exceeded.

Beams and slabs supported by concrete columns shall be formed so that the column forms may be removed without disturbing the supports for the beams or slabs.

Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms shall be brought to a true line and grade, or a wooden guide strip shall be placed at the proper location on the forms so that the concrete surface can be finished with a screed or template to the specified elevation, slope, or contour. At horizontal construction joints in walls, the forms on one side shall not extend more than 2 feet [600 mm] above the joint.

Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection.

2-2.02. Form Ties. Form ties shall have removable end and permanently embedded body, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie, and the permanently embedded portion shall be at least 1 inch [25 mm] back from the concrete face. Form ties for liquid-containing walls shall be provided with water stop washers located on the permanently embedded portions of the ties at the approximate center of the wall. The ties shall be smooth at the location of the water stop washer; continuously threaded systems will not be acceptable. Permanently embedded portions of form ties without threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete. Through-wall tapered removable ties will not be acceptable. The type of form ties used shall be acceptable to Structural Engineer of Record.

Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.

2-2.03. Edges and Corners. Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Equipment bases shall have formed beveled salient edges for all vertical and horizontal corners, unless specifically indicated otherwise on the Drawings. Unless otherwise noted, bevels shall be 3/4 inch [19 mm] wide.

PART 3 – EXECUTION

3-1. PLACEMENT. The limits of each concrete pour shall be determined by Design-Builder and acceptable to the Structural Engineer of Record.

Before concrete is placed, forms shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to the Structural Engineer of Record. Remove all frost, ice, and snow from within the formwork before concrete is placed.

3-2. TOLERANCES. Tolerances for cast-in-place concrete work shall be as indicated in ACI 347.3R, based upon the relevant formed concrete surface category.

3-3. FORM COATING. All concrete forms shall have form release agent applied to them before placement of concrete.

3-4. FORM REMOVAL. Forms shall not be removed from structures until the concrete in the structures has sufficient strength to support the weight of the structure and any superimposed load, including loads from construction operations. Design-Builder shall be responsible for limiting any applied loadings. There shall be no evidence of damage to concrete and no excessive deflection or distortion of members due either to the removal of forms or to loss of support.

Supporting formwork (soffit material only) for horizontal members shall not be removed until the concrete has attained at least 75 percent of the specified 28 day compressive strength as determined by cylinders made and cured in the field. Shoring systems for horizontal members shall not be removed until the concrete has attained the full specified 28 day compressive strength, but may be temporarily removed for the purpose of removing the soffit material as permitted above. Shoring shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.

When forms are removed before the specified curing is completed, measures shall be taken to immediately continue curing and to provide adequate thermal protection for the concrete.

End of Section

Section 03 15 19

CONCRETE JOINTS AND ACCESSORIES

PART 1 – GENERAL

1-1. SCOPE. This section covers concrete accessories including construction, contraction and expansion joints for cast-in-place concrete.

Dovetail anchor slots shall be as specified in the Masonry section.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-2. GENERAL. All accessories shall be accurately placed and all joints shall be accurately and properly constructed so cast-in-place concrete can be placed as specified and as indicated on the Drawings.

1-3. DRAWINGS AND DATA. All submittals of manufacturers' certificates of compliance, test data, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. MATERIALS.

PVC Waterstops	Extruded, virgin, elastomeric, polyvinyl chloride (PVC), white (no pigment), ribbed, 3/8 inch [9.5 mm] min thick. Reclaimed material will not be acceptable. Provide hog rings or grommets spaced at 12 inches [300 mm] on center entire length.
6 inches wide, at construction joints	Greenstreak “679” or Vinylex “R638”.

9 inches wide, at construction joints	Greenstreak “646” or Vinylex “R938”.
6 inches wide, at control joints	"O" bulb closed center section; Greenstreak "732" or Vinylex "RB638H".
9 inches wide, at control joints	"O" bulb closed center section; Greenstreak "735" or Vinylex "RB938H".
Expandable Waterstops, permitted only at locations indicated on Drawings	
For concrete sections that are at least 10 inches [300 mm] thick and 6 feet [1.8 m] high, and with at least two layers of reinforcement	Hydrophilic; bentonite free, chemically modified rubber. Adeka "Ultra Seal MC-2010MN" or Greenstreak "Hydrotite CJ-1020-2K". Adhesive and sealant as recommended by the manufacturer.
For other concrete sections	Hydrophilic; chemically modified rubber. Adeka "KBA-1510FP" or Greenstreak "Swellstop". Adhesive and sealant as recommended by the manufacturer.
Expansion joint materials	
Filler	Preformed sponge rubber, ASTM D1752, Type I.
Filler adhesive	As recommended by manufacturer.
Sealant	As specified in the Joint Sealants section.
Polyethylene film	NBS Product Standard PS17 or ASTM D4397, 6 mils [0.152 mm] or thicker.

Vapor retarder and seam tape	Polyolefin membrane, 15 mil [0.38 mm] min, ASTM E1745, Class A, with maximum water vapor permeance of 0.02 perms. Stego Industries “Stego Wrap 15 Mil”, Raven Industries “Vaporblock 15”, Reef Industries “Griffolyn 15 Mil Green”, W.R. Meadows “Perminator 15”, Insulation Solutions “Viper VaporCheck II”. Manufacturer recommended seam tape and pipe boots.
Bearing pads	Not used.
Epoxy bonding agent	As specified in Concrete Placing section.
Wedge inserts	Malleable iron, with galvanized askew-head bolts, nuts, and washers; Hohmann and Barnard "HW", Richmond "Peerless", or Weston "WC50".

PART 3 - EXECUTION

3-1. CONSTRUCTION JOINTS. Construction joints shall be made at locations indicated on the Drawings or where specified. Construction joints shall not be made at other locations without the concurrence of the Structural Engineer of Record.

3-1.01. Location. Construction joints shall be located as follows:

a. In Columns and Walls. At the underside of beams, girders, haunches, drop panels, and column capitals, and at floor levels. All haunches, drop panels, and column capitals shall be considered part of the supported floor or roof and shall be placed monolithically therewith. Column bases will not be required to be monolithic with the floor beneath. Walls shall be divided into sections not to exceed 60 feet [18 m], except at corners which shall be as indicated on the Drawings. Walls supporting beams shall have pockets blocked out so that the full beam cross section penetrates the full thickness of the wall. Where waterstops are required in the joint, the wall pocket shall be widened and deepened to prevent interference between the waterstop and the beam reinforcement.

b. In Beams and Girders. Within the middle third of the span, unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset by twice the width of the beam. Provisions for the transfer of shear and other forces through the construction joint shall be acceptable to the Structural Engineer of Record. Members shall be divided into pour sections not greater than 60 feet [18 m] in length.

c. In Suspended Slabs. At or near the center of the span in flat slab or T-beam construction. No joint will be permitted between a slab and a concrete beam or girder unless specifically required by the Drawings. Suspended floor systems shall be divided by construction joints into approximately square sections not to exceed 60 feet [18 m] in their longest dimension.

d. In Bottom Slab. Each bottom slab shall be divided into approximately square sections not to exceed 60 feet [18 m] in their longest dimension.

Construction joints in beams, girders, joists, and slabs shall be perpendicular to the planes of their surfaces.

3-1.02. Watertight Joints. Construction joints in the following locations shall be watertight and shall be provided with continuous waterstops.

a. For liquid-containing structures, provide in slabs below the liquid surface elevation, and in all perimeter walls to their full height.

b. For liquid-containing structures, provide in divider walls where it is possible for one side or “cell” to be out of service while the other remains liquid-containing.

c. For filters and clear water reservoirs, provide in all walls, base slabs, and top slabs.

d. Provide in other locations specifically indicated on the Drawings.

3-2. EXPANSION AND CONTRACTION JOINTS. Expansion joint filler shall be firmly bonded to the previously poured joint face with a suitable adhesive, and the new concrete shall be poured directly against the joint filler. Accessible edges of each expansion and contraction joint shall be sealed as specified in the caulking section.

3-3. WATERSTOPS.

3-3.01 Placement. Each waterstop shall be continuous throughout the length of the joint in which it is installed. Waterstops shall be clean, free from coatings, and shall be maintained in proper position until surrounding concrete has been

deposited and compacted. Waterstop embedment shall be equal on both sides of the joint.

Expandable waterstops shall be located as nearly as possible to the center of the joint and shall not be installed when air temperature falls outside the manufacturer's recommended range.

3-3.02. Storage and Handling. Expansion joint filler and elastomeric (PVC or TPV) waterstops shall be stored in a cool place protected from direct sunlight.

Metal waterstops shall be handled, transported, delivered, and stored in a manner which will prevent bends, dents, or corrosion.

3-3.03. Splices. Junctions between adjacent sections of metal waterstops shall be lapped 5 inches [130 mm] and securely bolted, screwed, or spot welded together.

Junctions between adjacent sections of elastomeric (PVC or TPV) waterstops shall be spliced in strict conformity with the recommendations of the manufacturer. Directional changes and intersections shall be factory fabricated by the waterstop manufacturer prior to delivery to the Site. Field splices will be acceptable only in straight sections.

Expandable waterstops shall be contact lapped a minimum distance of 8 inches [200 mm]. Voids shall be filled with sealant.

Where an expandable waterstop is used in combination with metal or PVC water stops, the expandable water stop shall be placed in contact and shall overlap a minimum distance of 12 inches [300 mm]. Voids shall be filled with sealant.

3-4. PLACEMENT. The limits of each concrete pour shall be determined by Design-Builder and shall be acceptable to the Structural Engineer of Record.

3-5. EMBEDMENTS. Anchor bolts, castings, steel shapes, conduits, sleeves, masonry anchors, and other objects that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.

Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be placed on the concrete side of the form or template. A second nut shall be placed on the other side of the form or template, and the two nuts shall be so adjusted that the bolt will be held rigidly in proper position.

3-6. DUCT BANK JOINTS. Hardened surfaces that are to receive additional concrete shall be prepared by removing all loose particles, scum, and laitance so that the aggregate is exposed. The hardened surface shall then be thoroughly wetted and a thin coating of neat cement mortar shall be spread over the entire

surface just before the fresh concrete is placed. The fresh concrete shall be puddled and spaded to eliminate any honeycomb or lack of mortar near the joint.

3-7. PLACEMENT AGAINST SUBGRADE. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high-pressure water spray.

3-7.01. Polyethylene Film. Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No. 4 [4.75 mm] sieve, such surfaces shall be covered with polyethylene film. Joints in the film shall be lapped at least 6 inches [152 mm] and taped.

3-7.02. Vapor Retarder. Vapor retarder shall be installed at the locations indicated on the Drawings. Installation shall be in accordance with ASTM E1643 and the manufacturer's recommendations. Joints in the retarder shall be sealed with waterproof sealing tape. Care shall be exercised to avoid tearing or puncturing the retarder. Any damage shall be promptly repaired, and the retarder shall be inspected for damage immediately before the concrete is placed.

3-8. BEARING PADS. Not used.

End of Section

Section 03 20 00

CONCRETE REINFORCING

PART 1 – GENERAL

1-1. SCOPE. This section covers reinforcement for cast-in-place concrete.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. All submittals of drawings, manufacturers' certificates of compliance, certification of reinforcement, reinforcement bar lists, placement drawings, test data, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

Bar lists and drawings for the fabrication and placing of reinforcement shall be submitted for review and shall have sufficient plans, elevations, and sections to adequately detail and label all reinforcement. The bar lists and drawings shall also include a reference to the structure in which the reinforcement will be installed and to the Drawing showing the reinforcement.

1-2.02. Manufacturer's Certificate of Compliance. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Owner’s Representative for the following materials:

Mechanical connectors

PART 2 – PRODUCTS

2-1. MATERIALS.

Bars, Except Weldable	ASTM A615 or A706, Grade 60, deformed. Shear bars shall be Grade 60, smooth.
Bars, Weldable	ASTM A706 or A615, Grade 60, deformed, with maximum carbon equivalent of 0.55%.
Column Spirals	ASTM A1064, cold drawn wire.

Welded Wire Fabric	ASTM A1064, Grade 70.
Bar Supports	CRSI Class 1, plastic protected; or Class 2, stainless steel protected. Precast concrete bricks shall not be used without approval of the Structural Engineer of Record.
Mechanical Connectors	Splicing system meeting Type 2 tensile requirements of ACI 318. Products shall have a current evaluation report verifying testing per ICC-ES AC 133.
Threaded Type	Dayton Superior “DBDI Splice System”, or Barsplice Products “Grip-Twist” system.
Locking Type	Dayton Superior “Bar-Lock Coupler” system, or Barsplice Products “Zap Screwlock Type 2 Mechanical Connector” system.
Protective Tape Wrap	Tapecoat "Tapecoat 20".

2-2. REINFORCEMENT. Reinforcement shall be accurately formed and shall be free from loose rust, scale, concrete splatter, and contaminants which reduce bond. Unless otherwise indicated on the Drawings or specified herein, the details of fabrication shall conform to ACI SP-66 and ACI 318. Reinforcement shall not be bent in the field without approval of the Structural Engineer of Record.

2-2.01. Splices. Splices shall conform to the details indicated on the Drawings. Splices at locations other than those indicated on the Drawings shall be submitted to the Structural Engineer of Record for review and concurrence.

2-2.02. Mechanical Connectors. Mechanical connectors shall be used only as indicated on the Drawings. Connections in adjacent bars shall be spaced at least 30 inches [760 mm] apart.

2-2.03. Welding. Except where indicated on the Drawings, welding or tack welding of reinforcement is not permitted. Preheating and welding shall conform to AWS D1.4. Reinforcement which has been welded improperly or without the Structural Engineer of Record's concurrence shall be removed and replaced.

2-2.04. Repair of Epoxy Coating. When epoxy-coated reinforcing bars are specified, before placing epoxy-coated reinforcement in the work, Design-Builder

shall repair all damaged epoxy coatings and shall check the coating for holidays in accordance with the procedures set forth in ASTM A775. All reinforcement shall be free of holidays prior to placement in the work.

Damaged epoxy coating shall be repaired as recommended by the manufacturer using patching material provided by the manufacturer.

Coatings damaged by handling and placing after onsite testing shall be repaired as specified. The maximum amount of damaged coating shall not exceed 0.5 percent of the surface area of each bar.

After completion of welding on epoxy-coated reinforcement, when acceptable to the Structural Engineer of Record, damage to the coating shall be repaired as specified. All welds and steel splice members, including mechanical connections when used to splice bars, shall be coated with the same material as used to repair coating damage.

PART 3 – EXECUTION

3-1. STORAGE AND HANDLING. Reinforcing steel shall be carefully handled and shall be stored on supports which prevent the steel from touching the ground.

Epoxy-coated reinforcement shall be handled using equipment with protected contact areas. Bundles or stacks of epoxy-coated reinforcement shall be lifted at multiple points to prevent abrasion from sags. Epoxy-coated reinforcement shall not be dropped or dragged and shall be stored on protective cribbing. Faded or chalking coating will not be cause for rejecting epoxy-coated reinforcement.

3-2. PLACEMENT. Reinforcement shall be accurately positioned on supports, spacers, hangers, or other reinforcement, and shall be secured in place with wire ties or suitable clips. Tolerances shall be as stipulated in ACI 117 and ACI 318 unless otherwise indicated.

Reinforcement at the bottom of concrete slabs and mats shall not be supported from contact with subgrade by the use of metal supports or bent reinforcement.

Where reinforcement in beams is placed in two or more layers, the bars in the upper layer shall be placed directly above the bars in the lower layer.

Reinforcement for beams or slabs which are supported by concrete columns shall not be installed until after the concrete for the column has been placed.

Before concrete is placed, reinforcement shall be rigidly secured in proper position. All surfaces encrusted with dried concrete from previous placements

shall be cleaned and the entire installation shall be acceptable to the Structural Engineer of Record. Remove all frost, ice, and snow before concrete is placed.

Epoxy-coated reinforcement shall be fastened with nylon, epoxy, or plastic-coated tie wire.

3-3. PLACING CONCRETE. Concrete shall be placed and compacted in wall or column forms before any reinforcement is placed in the system to be supported by such walls or columns.

3-4. DUCT BANKS. All reinforcement and other magnetic materials installed in duct banks shall be installed parallel to the individual ducts, unless they enclose all the ducts of the duct bank.

End of Section

Section 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1-1. SCOPE. This section covers procurement of all cast-in-place concrete, including concrete materials, limiting requirements, mixture design, and performance requirements, and delivery to the Site through discharge at the end of the delivery truck chute.

Work beyond the end of the delivery truck chute is covered in the Concrete Forming, Concrete Joints and Accessories, Concrete Reinforcing, Concrete Placing, Concrete Finishing, and Concrete Curing sections.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-2. GENERAL. All cast-in-place concrete shall conform to the limiting requirements of this specification including Table 1.

1-2.01. Concrete Classifications. Concrete classifications shall be defined and used as indicated for the following classes:

Concrete Classifications

Class	Class Description
A.	Structural Concrete
A1.	Concrete for Liquid-Containing Structures. Concrete for liquid-containing environmental structures, liquid-containing tanks, interior suspended slabs in high humidity areas, headwalls, chemical storage or containment areas, below grade structures exposed to groundwater under normal conditions, and all other concrete not otherwise indicated.
A2.	Small Aggregate Concrete; Congested Areas. Structural small aggregate concrete shall be used in all areas (including liquid-containing structures) where the clear distance between reinforcement, conduit, or embedded items is less than the largest dimension of coarse aggregate particles in the structural concrete.

Class Class Description

A3. Concrete for Non-Liquid-Containing Structures. Concrete for footings, foundations, manholes, catch basins, pan-formed joists, and all other structural concrete other than for liquid-containing structures.

A4. Mortar Puddle. Not used.

A5. Drilled Pier Concrete. Not used.

B. Exterior Flatwork Concrete. Concrete for exterior slabs on grade, plant pavement, sidewalks, curbs and gutters, and small equipment pads.

C. Architectural Concrete. Not used.

D. Miscellaneous Concrete

D1. Ductbanks, Pipe Blocking, Concrete Fill, and Pipe Encasement Concrete. Concrete used in ductbanks, pipe blocking, concrete fill and pipe encasements.

D2. Underwater Concrete. Not used.

D3. Mass Concrete. Not used.

D4. Pan Stairs Concrete. Not used.

D5. Wash Water Trough Concrete. Not used.

D6. Composite Topping Concrete. Not used.

D7. Lean Concrete. Used as a fill material for over-excavations or for mud slabs below foundations. Controlled Low-Strength Material (CLSM) used as an easily removable fill material is covered in the Excavation and Fill for Structures section.

1-3. SUBMITTALS. All data shall be submitted in accordance with the Submittals Procedures section, unless otherwise specified herein.

The required submittal data for each Class of concrete shall be as indicated in Tables 2A, 2B, and 2C.

1-3.01. Preliminary Review of Materials. Reports covering the source and quality of concrete materials proposed for the work shall be submitted to the Structural Engineer of Record for review within 30 days after the preconstruction conference.

A manufacturer's certificate of compliance, which includes copies of independent test results confirming compliance with specified requirements, shall be submitted for the following materials:

Cement.

Admixtures.

Fly Ash.

Slag Cement.

Fibers.

1-3.02. Proposed Mixture Proportions. Data indicating the proposed material quantities in each Class of concrete shall be submitted to the Structural Engineer of Record for review within 30 days after the preconstruction conference (no less than 7 days prior to placement).

1-3.03. Field Test Record Data. Concrete mixture field test record performance data shall be submitted to the Structural Engineer of Record for review and acceptance. Field test record data shall be acceptable only for the Classes of concrete indicated as such in Table 2C.

1-3.04. Laboratory Trial Mixture Test Results. Laboratory trial mixture testing shall not begin until materials and proposed mixture proportions have been reviewed and are acceptable to the Structural Engineer of Record. Trial mixture testing shall be performed for all Classes of concrete where field test record data is not acceptable as a means of qualifying the mixture.

1-4. STORAGE AND HANDLING. Cement, slag cement and fly ash shall be stored in suitable moistureproof enclosures. Cement, slag cement and fly ash which have become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches [150 mm] of aggregate piles in contact with the ground shall not be used.

PART 2 - PRODUCTS

2-1. LIMITING REQUIREMENTS. Unless otherwise specified, each concrete mixture shall be designed and controlled, within the following limits, to provide a dense, durable concrete suitable for the expected service conditions.

Concrete materials shall be selected and concrete shall be proportioned, batched, mixed, and delivered in a manner that will minimize shrinkage and

cracking as specified herein, and in accordance with Chapters 3 and 8 of ACI 224R. Concrete temperatures shall be controlled before and until delivery at the end of the delivery truck chute to minimize cracking. Any rise in concrete temperature caused by environmental conditions that will be conducive to excessive shrinkage shall be controlled.

For each class of concrete, each concrete mixture shall be designed and concrete shall be controlled within the limits in the specification and in Table 1.

2-1.01. Cementitious Material Content Limits. The minimum quantity of Portland cement in the concrete shall be as indicated in Table 1.

The cementitious material content shall not be increased beyond the Table 1 values more than necessary to achieve the required f'_{cr}.

Design-Builder may substitute fly ash for Portland cement within the percentage ranges indicated in Table 1, on the basis of 1.0 lbs [1.0 kg] of fly ash added for each lb [kilogram] of Portland cement reduction.

Design-Builder may substitute slag cement for Portland cement within the percentage ranges indicted in Table 1 on the basis of 1.0 lbs [1.0 kg] of slag cement added for each lb [kilogram] of Portland cement reduction.

Mixtures using slag cement in combination with fly ash will not be acceptable.

2-1.02. Maximum Water-Cementitious Material Ratio. The maximum water-cementitious material ratio shall be on a cement mass basis, or, if fly ash or slag cement is used, the combined mass of cement plus fly ash or slag cement shall be used to determine the water-cementitious materials ratio. Limiting maximum water-cementitious material ratios are indicated in Table 1.

2-1.03. Aggregates. Aggregates shall comply with ASTM C33 except as specified herein. Fine aggregate shall be clean natural sand. Artificial or manufactured sand shall not be used unless acceptable to the Structural Engineer of Record. Coarse aggregate shall be crushed rock, washed gravel, or other inert granular material, meeting Class 4S requirements, except that clay and shale particles shall not exceed values indicated in Table 1.

Gradation of coarse aggregate shall conform to maximum nominal size grading requirements of ASTM C33. When a combination of two or more sizes is used, the combined gradation shall meet ASTM C33 requirements.

Aggregates used in concrete shall have a combined aggregate distribution similar to the aggregates used in the concrete trial mixtures. Reports of individual aggregates shall include sieve sizes 1-1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, and No. 50 [38 mm, 25 mm, 19 mm,

12.5 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.118 mm, 600 µm, and 300 µm] in accordance with ASTM E11.

Specified sand equivalent for fine aggregate shall be not less than indicated in Table 1 for an average of 3 samples tested in accordance with ASTM D2419.

To comply with the specified concrete shrinkage test requirements, the clay and shale content of the aggregates may need to be reduced by washing the aggregate.

2-1.04. Ratio of Fine to Total Aggregates. The ratio of fine to total aggregates, based on solid volumes (not weights), shall be as follows:

Maximum Nominal Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
3/8 inch [9.5 mm]	0.45	0.60
1/2 inch [12.5 mm]	0.40	0.55
3/4 inch [19 mm]	0.35	0.50
1 inch [25 mm]	0.30	0.46
1-1/2 inch [37.5 mm]	0.25	0.40

2-1.05. Slump. Concrete slump shall be kept as low as possible, consistent with proper handling and thorough consolidation. Prior to the addition of admixtures, slump shall be at least 2 inches [50 mm] and shall not exceed the maximum slump as indicated in Table 1.

When superplasticizer is dispensed at the ready-mix plant, the concrete mixture design shall be based on a maximum slump as indicated in Table 1. When superplasticizer is dispensed at the Site, the slump of the concrete delivered shall not exceed the maximum slump as indicated in Table 1 before superplasticizer is added.

2-1.06. Initial Set. The initial set, as determined by ASTM C403, shall be attained 5-1/2 hours ±1 hour after the water and cementitious materials are added to the aggregates for each concrete mixture. The quantity of retarding admixture shall be adjusted to compensate for variations in temperature and job conditions.

2-1.07. Total Air Content. The total volumetric air content of concrete after placement shall be as indicated in Table 1, and within ±1.5 percent. Air-

entraining admixture may be omitted from concrete for interior slabs which are to be steel trowel finished.

2-1.08. Admixtures. Only approved or specified admixtures shall be used.

Unless otherwise acceptable to the Structural Engineer of Record, all admixtures shall be from one manufacturer and shall be compatible. Admixtures that are compatible with other admixtures and concrete materials shall not have an adverse effect on the required properties of the concrete nor the specified limiting requirements. The admixture content, batching method, and time of introduction to the mixture shall comply with these specifications and with the manufacturer's recommendations for minimum shrinkage. The admixture manufacturer shall provide qualified field services as necessary, at no additional cost to Owner.

Admixtures used in the concrete shall be reviewed and accepted by the Structural Engineer of Record prior to conducting the laboratory trial mixture testing and the shrinkage testing. No calcium chloride nor admixture containing chloride from sources other than residual impurities in admixture ingredients will be permitted.

Combination of admixtures which cause premature or local dehydration or post-compaction settlement of the concrete surface shall not be used. If any such undesirable characteristics are observed, the use of the mixture shall be discontinued and an alternate mixture design used.

All liquid-containing (Class A1) concrete, and small aggregate (Class A2) concrete that is placed in liquid-containing structures, shall include a high-range water reducing admixture (superplasticizer). Water-reducing admixtures are not required for Classes D1 and D7, but may be included at Design-Builder’s option. For all other non-liquid-containing concrete, a water-reducing admixture shall be used.

Superplasticizer may be dispensed into the concrete at the plant or on the Site and shall be mixed in accordance with the admixture manufacturer's recommendations. Each superplasticizer dose, when dispensed at the Site, shall be easily verifiable and recorded on the delivery ticket. The superplasticizer for each load shall be accurately proportioned into a separate container prior to dispensing the admixture into the concrete. When truck-mounted dispensers are used, the system shall not be flushed or cleaned with water until after the entire load of concrete has been discharged. When permitted by the Structural Engineer of Record, redosing of concrete with superplasticizer shall be done only once. Redosing procedures shall be as recommended by the admixture manufacturer.

A shrinkage reducing admixture may be added to Class A1 concrete. It shall replace an equal volume of mixing water or as otherwise recommended by the admixture manufacturer. The quantity of air entrainment admixture shall be adjusted as required by the admixture manufacturer to keep mixture air content within specified limits.

2-1.09. Fiber Concrete. Fiber concrete shall be used only where noted on the Drawings. Polypropylene micro fibers shall be added to the concrete materials at the time the materials are batched at the rate of 1.5 lbs/cu yd [0.90 kg/m^3]. Batching and mixing procedures shall be in accordance with the manufacturer's recommendations. Fibers shall be randomly oriented and uniformly distributed throughout the concrete.

2-1.10. Strength. In addition to the other limiting requirements to achieve durability and minimize shrinkage, the minimum acceptable compressive strengths of concrete tested at the end of the delivery truck chute, as determined by ASTM C39, shall be as indicated in Table 1.

Adequate test cylinders taken at the point of placement shall also be made to verify that Design-Builder's concreting procedures comply with applicable industry standard procedures.

2-1.11. Pumped Concrete. Coarse aggregate size for pumped concrete mixtures shall be limited to a nominal maximum of 1-1/2 inch [37.5 mm].

2-1.12. Water-Soluble Chloride. Maximum water-soluble chloride ion concentrations in hardened concrete at an age of 28 days shall not exceed the limits expressed as a percentage of mass of cementitious materials as indicated in Table 1.

Test results shall be reported as the percentage of water-soluble chloride ions in the concrete and as a percentage of chloride ion relative to the mass of cementitious materials in the concrete.

Testing of the concrete components for water-soluble chloride ions may be done at the discretion of Design-Builder. Copies of the reports on such tests shall be furnished to the Structural Engineer of Record.

The hardened concrete and each gradation of aggregate used in the concrete shall be tested each time a chloride ion test is conducted on a concrete mixture.

2-1.13. Laboratory Shrinkage Limits. Based on the modified ASTM C157 test procedures as specified herein, the shrinkage limits of concrete shall be the average drying shrinkage of each set of three test specimens cast in the

laboratory from a trial mixture as measured at the 21 days drying age, and shall not exceed the values in Table 1.

2-1.14. NSF 61 Compliance. Not used.

2-1.15. Mineral Colored Concrete. Mineral colored concrete shall be used where indicated on the Drawings. The color of the concrete shall be as noted on the Drawings. The quantity of mineral coloring admixture added shall be as recommended by the color admixture manufacturer for a deep, intense color tone.

2-1.16. Cold Weather Concrete. Except as modified herein, cold weather concrete shall comply with ACI 306.1. The temperature of concrete at the point of delivery at the end of the delivery truck chute shall be not less than that indicated in ACI 306.1 for corresponding outdoor temperature (in shade) at the time of placement.

When delivered, heated concrete shall be not warmer than 80°F [26°C].

2-1.17. Hot Weather Concrete. Except as modified herein, hot weather concrete shall comply with ACI 305.1. At air temperatures of 90°F [32°C] or above, concrete shall be kept as cool as possible before and during delivery. The temperature of the concrete at the time of delivery at the end of the delivery truck chute shall not exceed the values indicated in Table 1.

2-2. MATERIALS.

Cement	ASTM C 150, Type V or Type II/V. Low Alkali.
Fly Ash	ASTM C618, except that loss on ignition shall not exceed 4 percent. Class F or Class C are acceptable, but Class C shall also be qualified for moderate sulfate resistance as described in ASTM C618, Table 3, Procedure A. The test for sulfate resistance shall be in accordance with ASTM C1012.
Slag Cement	ASTM C989, Grade 100 or Grade 120.

Aggregates, Fine and Coarse	As specified in Limiting Requirements paragraph.
Water	Potable. Water from concrete production operations shall not be used.
Admixtures	
Water Reducing/Normal Set	ASTM C494, Type A, except as otherwise specified herein.
Water Reducing/Retarding	ASTM C494, Type D, except as otherwise specified herein.
Air-Entraining	ASTM C260.
High Range Water Reducing/Normal Set	ASTM C494, Type F, extended slump life type, except as otherwise specified herein.
High Range Water Reducing/Retarding	ASTM C494, Type G, extended slump life type, except as otherwise specified herein.
Shrinkage Reducing Admixture	GCP Applied Technologies (Grace) “Eclipse 4500”, Euclid “Eucon SRA”, or BASF “MasterLife SRA 035”. These admixtures may not be usable in mixtures that require NSF 61 certification.
Mineral Coloring	Nonfading mineral coloring unaffected by sunlight or free alkali; Davis Colors "Mix-Ready", L.M. Scofield "Chromix", or Euclid “Super Concentrated Mortar Color”.
Fibers	Collated, fibrillated, polypropylene fibers; Propex “Fibermesh”, Forta “Mighty-Mono”, or GCP Applied Technologies (Grace) “MicroFiber”.

2-3. MIXTURE DESIGN AND TESTING. As stipulated in the Quality Control section, all reports and tests required for preliminary review of materials and for laboratory trial mixtures shall be made by an independent testing laboratory at the expense of Design-Builder. Mixtures shall be adjusted in the field as

necessary, within the limits specified, to meet the requirements of these specifications. If the source of any concrete materials is changed during the contract, concrete work shall pause until the new materials and the new mixture design are tested in accordance with the specified requirements.

2-3.01. Preliminary Review of Materials. The tests and reports required shall be as indicated in Table 2A. Review of these reports shall be for general acceptability only, and continued compliance with all contract provisions shall be required.

Aggregate reports shall be no more than 90 days old at time of submittal.

Alkali-aggregate reactivity potential shall be determined by one of the following procedures. A satisfactory service record evaluation as described in ASTM C33 will not be acceptable.

1 Test fine and coarse aggregates in accordance with ASTM C1260. Aggregates which are classified as innocuous may be used without further testing. Aggregates which are not innocuous shall be further tested in accordance with ASTM C227 or C1105 (as appropriate), using a cement containing less than 0.6 percent alkalies.

2 Test fine and coarse aggregates in accordance with ASTM C1567, using a single aggregate with all cementitious materials selected for the Project. The fine and coarse aggregates shall not be combined and used in a single test. This test may only be used for mixtures that contain slag cement or fly ash, and those products shall not have an alkali content greater than 4.0 percent sodium oxide equivalent. Combinations of cementitious materials and aggregate which do not indicate a potential for alkali reactivity may be used without further testing. Mixture combinations which indicate a potential for alkali reactivity shall have the ingredients and/or proportions modified and then the test shall be repeated.

3 Test fine and coarse aggregates in accordance with ASTM C1293. Concrete mixtures containing only portland cement (without pozzolan or slag cement) shall be tested accordingly and have a measured expansion of 0.04 percent or less at one year duration. Concrete mixtures containing pozzolan or slag cement shall be tested with those ingredients in proportions matching that of the proposed mixture, and shall have a measured expansion of 0.04 percent or less at two years duration.

At the discretion of the Structural Engineer of Record, testing in addition to that indicated herein or in Appendix X1 of ASTM C33 may be performed on

potentially reactive aggregates. Nonreactive aggregates shall be imported if, in the opinion of the Structural Engineer of Record, local aggregates exhibit unacceptable potential reactivity.

2-3.02. Proposed Mixture Proportions. Proposed proportions for each Class of concrete shall meet the limiting requirements indicated herein.

2-3.03. Mixture Testing. Test results on each Class of concrete shall be submitted for review and shall be acceptable to the Structural Engineer of Record before concrete work is started. The reports shall include the information indicated in Table 2C.

2-3.03.01. Field Test Record Data. If indicated as acceptable in Table 2C, concrete mixtures may be qualified based upon field test record performance data in lieu of laboratory trial mixtures. Field test data records shall be from the production facility being used on the current Project and shall have been performed in the past 12 months. Field test records shall represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days.

2-3.03.02. Laboratory Trial Mixture Testing. Trial mixtures shall be tested in the laboratory for each size and combined gradation of aggregates and for each consistency as indicated and intended for use on the work and as specified.

Concrete ingredients shall be measured and mixed in the laboratory. Concrete test specimens shall be made, cured, and stored in accordance with ASTM C192 and tested in accordance with ASTM C39.

Concrete proportions shall be established based on laboratory trial mixtures that meet the following requirements:

a. The combination of materials shall be as proposed for use in the work.

b. Mixtures shall conform with the limiting requirements specified herein.

c. The required average compressive strength, f'_{cr}, of the trial mixture shall exceed the specified minimum acceptable compressive strength, f'_{cr}, as required in Table 1.

d. Trial mixtures of the proportions and consistencies specified for the work shall be prepared. When a three point curve is required by Table 2C, the three concrete trial mixtures shall reflect the cement content proposed for the Project and for the indicated concrete class at three water-cementitious material ratio contents at or lower than indicated in Table 1. The compressive strength of the cylinders made from the three trial mixtures shall produce a range of compressive strengths exceeding or encompassing the f'_{cr} required for the work.

e. For each proposed concrete mixture that is required to be tested as indicated in Table 2C, compressive strength test cylinders shall be made for each testing age. Each change in the water-cementitious materials ratio shall be considered a new concrete mixture. Each mixture shall be tested at the ages of 7 days and 28 days.

f. When a three point curve is required in Table 2C, the results of the cylinder tests for each water-cementitious materials ratio at each age shall be plotted as a curve showing the relationship between compressive strength (along y-axis) and the water-cementitious materials ratio (along x-axis). The water-cementitious materials ratio and the associated average compressive strength for the Project concrete mixture shall be selected from the 28 day curve. The maximum water-cementitious materials ratio specified in the limiting requirements shall still apply even if the curve indicates that the concrete strength would be adequate at a higher ratio. The cement content and mixture proportions to be used shall be such that the selected water-cementitious materials ratio will not be exceeded at specified maximum slump. These concrete mixture proportions shall be submitted for review in accordance with the Submittals Procedures section.

g. When a shrinkage reducing admixture is proposed, trial mixtures shall be prepared with and without the shrinkage reducing admixture.

2-3.03.03. Testing Procedures. Concrete mixture testing procedures shall be as specified herein, and reports for these tests shall be prepared specifically for this Project.

Aggregates shall be sampled and tested in accordance with ASTM C33. The bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM C128.

Slump shall be determined in accordance with ASTM C143. Unit weight (mass) shall be determined in accordance with ASTM C138. Total air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138. Concrete temperature shall be determined in accordance with ASTM C1064.

Initial set tests shall be made at ambient temperatures of 70°F and 90°F [21°C and 32°C] to determine compliance with the specified time for initial set. The test at 70°F [21°C] shall be made using concrete containing the specified normal set/water-reducing admixture and, when required, air-entraining admixture. The test at 90°F [32°C] shall be made using concrete containing the specified retarding/water-reducing admixture and, when required, air-entraining admixture. Initial set shall be determined in accordance with ASTM C403.

Cylinders shall be 6 inches [150 mm] diameter by 12 inches [300 mm] high for concrete mixes using a maximum nominal aggregate size of 1 inch [25 mm] or larger. Cylinders may be either 6 inches [150 mm] diameter by 12 inches [300 mm] high, or 4 inches [100 mm] diameter by 8 inches [200 mm] high for concrete mixes using a maximum nominal aggregate size of less than 1 inch [25 mm]. The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch [100 mm] diameter cylinders, and at least two cylinders when using 6 inch [150 mm] diameter cylinders. All tests for a particular class of concrete shall be performed using the same sized cylinders for the duration of the work.

Water-soluble chloride ion shall be determined in accordance with ASTM C1218.

A drying shrinkage test shall be conducted on the trial mixture with the maximum water-cementitious materials ratio used to qualify each proposed concrete mixture design using the concrete materials, including admixtures, that are proposed for the Project. Three test specimens shall be prepared for each test. Drying shrinkage specimens shall be 4 inch by 4 inch by 11 inch [100 by 100 by 275 mm] prisms with an effective gauge length of 10 inches [250 mm], fabricated, cured, dried, and measured in accordance with ASTM C157 except with the following modifications:

> Specimens shall be removed from the molds at an age of 23 hours ±1 hour after batching, shall be placed immediately in water at 73°F ±3°F [23°C ±2°C] for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in lime-saturated water as specified in ASTM C157. Measurement to determine expansion expressed as a percentage of original length shall be taken at age 7 days. The length at 7 days shall be the base length for drying shrinkage calculations ("zero" days drying age). Specimens then shall be stored immediately in a humidity controlled room maintained at 73°F ±3°F [23°C ±2°C] and 50 percent ±4 percent relative humidity for the remainder

of the test. Measurements to determine shrinkage expressed as a percentage of the base length shall be reported separately for 7, 14, and 21 days ±4 hours of drying from "zero" days after 7 days of moist curing for a total of 28 days from the date of casting.

Drying shrinkage deformation for each specimen shall be computed as the difference between the base length (at "zero" days drying age) and the length after drying at each test age. Results of the shrinkage test shall be reported to the nearest 0.001 percent. If drying shrinkage of any specimen deviates from the average for that test age by more than 0.004 percent, the results for that specimen shall be disregarded.

The average drying shrinkage of each set of 4 inch by 4 inch by 11 inch [100 by 100 by 275 mm] test specimens made in the laboratory from a trial mixture shall not exceed the values required in Table 1.

PART 3 – EXECUTION

3-1. BATCHING, MIXING, AND DELIVERY. Concrete shall be furnished by an acceptable ready-mixed concrete supplier, and shall conform to ASTM C94 except as indicated otherwise in this specification.

3-1.01. Delivery Tickets. A delivery ticket shall be prepared for each load of ready-mixed concrete and a copy of the ticket shall be provided by the truck operator at the time of delivery. Tickets shall indicate the name and location of

Design-Builder, the project name, the mixture identification, the quantity of concrete delivered, the quantity of each material in the batch, the outdoor temperature in the shade, the time at which the cementitious materials were added, and the numerical sequence of the delivery.

3-1.02. Mixing Water. Mixing water shall not be added in transit. Any amount of water withheld from the truck mixer shall be clearly indicated on the delivery ticket. Water added at the site shall not exceed the amount withheld, and shall not be added without oversight by Owner’s on site inspector.

3-1.03. Consistency. The consistency of concrete shall be suitable for the placement conditions. Aggregates shall flow uniformly throughout the mass, and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

3-2. DESIGN-BUILDER'S ON-GOING MATERIAL CONTROL TESTING. The following tests and test reports are required during the progress of the work and shall be made at the expense of Design-Builder. The frequency specified herein for each field control test is approximate and subject to change as determined by the Structural Engineer of Record.

3-2.01. Aggregate Gradation. Each 200 tons [180 Mg] of fine aggregate and each 400 tons [360 Mg] of coarse aggregate shall be sampled and tested in accordance with ASTM D75 and C136, for verification that the gradations continue to meet ASTM C33 requirements. If lesser quantities of aggregates are used, the sampling and testing shall occur at least once every 6 months.

3-2.02. Sand Equivalent. The sand equivalent test shall be conducted each time the sand gradation tests are conducted.

3-2.03. Fly Ash. Each 400 tons [360 Mg] of fly ash shall be sampled and tested in accordance with ASTM C618 and C311. Design-Builder shall supply the Structural Engineer of Record with certified copies of supplier's (source) test reports showing chemical composition and physical analysis for each shipment delivered to Design-Builder and certifying that the fly ash complies with the specifications. The certificate shall be signed by the fly ash supplier.

3-2.04. Cement. Each 1500 tons [1350 Mg] of cement shall be sampled and tested in accordance with ASTM C150. Design-Builder shall supply the Structural Engineer of Record with certified copies of supplier's (source) test reports showing chemical composition and physical analysis, and certifying that the cement complies with ASTM C150 and these specifications. The certificate shall be signed by the cement manufacturer.

3-2.05. Slag Cement. Each 800 tons [720 Mg] of slag cement shall be sampled and tested in accordance with ASTM C989. Design-Builder shall supply the Structural Engineer of Record with certified copies of supplier’s (source) test reports showing chemical composition and physical analysis, and certifying that the slag cement complies with ASTM C989 and these specifications. The certificate shall be signed by the slag cement manufacturer.

3-3. OWNER'S FIELD CONTROL TESTING. Field control tests, including slump, air content, and making compression test cylinders, shall be performed by Owner’s testing laboratory personnel, at the expense of Owner. Design-Builder shall provide access to all facilities and the services of one or more employees as necessary to assist with the field control testing.

The frequency specified herein for each field control test is approximate and subject to change as determined by the Structural Engineer of Record.

The Structural Engineer of Record may require field testing prior to the addition of superplasticizer at the Site to determine compliance with the specifications. Field testing after the addition of superplasticizer shall be conducted as specified and as needed to determine that the concrete is in compliance with the

specifications. Air content tests shall be conducted whenever field tests are conducted.

3-3.01. Slump. A slump test shall be made for each 100 cubic yards [80 m^3] of concrete. Slump shall be determined in accordance with ASTM C143.

3-3.02. Air Content. An air content test shall be made on concrete from one of the first three batches mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138.

3-3.03. Unit Weight. A unit weight test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. Unit weight shall be determined in accordance with ASTM C138.

3-3.04. Concrete Temperature. A concrete temperature test shall be made on concrete from the first batch of concrete mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. During hot or cold weather concreting operations, temperature shall be checked not less than once per hour. Concrete temperature shall be determined in accordance with ASTM C1064.

3-3.05. Water-Soluble Chloride Ion. Water-soluble chloride ion testing shall be performed once for each 1,000 cubic yards [764 m^3] of concrete in accordance with ASTM C1218.

3-3.06. Compression Tests. One set of concrete compression test cylinders shall be made not less than once each day concrete is placed, not less than once for each 100 cubic yards [80 m^3] of each class of concrete, and not less than once for each 5000 square feet [465 m^2] of surface area for slabs or walls. Half of the cylinders of each set shall be tested at an age of 7 days and the remaining cylinders shall be tested at an age of 28 days.

Test cylinders shall be made, cured, stored, and delivered to the laboratory in accordance with ASTM C31 and tested in accordance with ASTM C39.

Cylinders shall be 6 inches [150 mm] diameter by 12 inches [300 mm] high for concrete mixes using a maximum nominal aggregate size of 1 inch [25 mm] or larger. Cylinders may be either 6 inches [150 mm] diameter by 12 inches [300 mm] high, or 4 inches [100 mm] diameter by 8 inches [200 mm] high for concrete mixes using a maximum nominal aggregate size of less than 1 inch [25 mm]. The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch [100 mm] diameter cylinders, and at least two cylinders when using 6 inch [150 mm] diameter cylinders. All tests for a

particular mixture class shall be performed using the same sized cylinders for the duration of the work and shall match the cylinder size used for the trial mixtures.

Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the number of the delivery truck or batch, the air content, the slump, the unit weight, and the concrete temperature.

3-3.07. Shrinkage Tests. Concrete shrinkage tests shall be performed once for each 1,000 cubic yards [764 m^3] of concrete with controlled shrinkage that is placed and shall be made on concrete from a batch of concrete from which concrete compression test cylinders are made. Shrinkage testing shall be conducted as specified for the preliminary trial mixtures.

The average drying shrinkage of each set of test specimens cast in the field from concrete delivered to the Site and sampled at the end of the delivery truck chute, as measured at the 21 days drying age, shall not exceed the values indicated in Table 1.

3-3.08. Test Reports. Five copies of each test report shall be prepared and distributed by the testing laboratory to the Owner, Resident Project Representative (two copies), Structural Engineer of Record, and Design-Builder, in accordance with the Quality Control section.

3-4. EVALUATION AND ACCEPTANCE OF CONCRETE. Concrete will be evaluated for compliance with all requirements of the specifications. Concrete strength will be only one of the criteria used for evaluation and acceptance of the concrete. The results of all tests performed on the concrete and other data and information concerning the procedures for handling, placing, and curing concrete will be used to evaluate the concrete for compliance with the specified requirements.

Compression tests will be evaluated in accordance with ACI 318 and as specified herein. A strength test shall be the average of the compressive strengths of two 6 inch [150 mm] diameter cylinders or three 4 inch [100 mm] diameter cylinders, made from the same concrete sample tested at 28 days.

3-4.01. Compression Test Evaluation. Compressive strength test results will be evaluated for compliance with the specified strength requirements. The strength level of the concrete will be considered satisfactory when the averages of all sets of three consecutive strength tests equal or exceed the specified compressive strength, f'_c, and no individual strength test result falls below the specified compressive strength by more than 500 psi [3.5 MPa].

3-4.02. Inspection of Concrete Supplier. Both scheduled and unscheduled visits by inspectors on days of concrete pours shall be accommodated. Inspectors shall be allowed access to delivery tickets and mixture proportions.

TABLE 1 – LIMITING REQUIREMENTS															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1.	**Minimum Cement Content**, lbs/cubic yard; based on maximum slump and maximum water-cementitious material ratio.														
	Maximum Nominal Aggregate Size, ASTM C33 aggregate														
	Size No. 467 (1-1/2")	---	---	489	---	440	464	---	---	600*	**	---	---	---	380
	Size No. 57 (1")	536	---	514	---	460	489	514	460	620*	**	---	---	---	400
	Size No. 67 (3/4")	564	---	526	---	480	514	526	480	640*	**	---	---	526	420
	Size No. 7 (1/2")	---	601	555	---	500	526	555	500	660*	**	---	584	555	440
	Size No. 8 (3/8")	---	636	564	---	520	555	564	520	680*	**	636	601	564	460
	Fine Aggregate, (Sand)	---	---	---	750	---	---	---	---	---	---	---	---	---	---
2.	**Compressive Strength**, minimum; psi														
	Field, 7 days;	3375	3375	3375	3000	3000	3000	3000	2250	3000	**	3000	3000	3000	1500
	Field, 28 days; f'_c	4500	4500	4500	4000	4000	4000	4000	3000	4000	**	3000	4000	4000	2000
	Laboratory, 28 days; f'_{cr}	5700	5700	5700	5200	5200	5200	5200	3200	5200	**	4200	5200	5200	2000
3.	**Maximum water-cementitious material ratio**	0.42	0.42	0.45	0.45	0.45	0.48	0.45	0.45	0.45	**	0.45	0.45 0.40[a]	0.42	0.75
4.	**Maximum nominal coarse aggregate size, inches**	1	1/2	1-1/2	Sand	1-1/2	1-1/2	1	1	1-1/2	**	3/8	1/2	3/4	1-1/2
5.	**Maximum slump**, inches														
	Slump before super-plasticizer added	3	3	4	6	6	4	3	5	6	**	4	4	4	6
	Slump after adding superplasticizer	8	8	8	8	8	8	8	8	9	**	8	8	8	10

TABLE 1 – LIMITING REQUIREMENTS															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
6.	**Total air content**, percent, (± 1.5 %)	6	6	6	6	6	6	6	---	---	**	---	6	6	---
7.	**Fly ash replacement, percent range**	15-25	15-25	15-25	15-25	15-30	15-25	15-25	15-30	15-25	**	15-30	15-35	15-25	15-30
8.	**Slag cement replacement, percent range**	25-50	25-50	25-50	0	25-50	25-30	0	25-50	0	**	0	0	25-50	25-50
9	**Testing limits**														
	Sand equivalent, min. percent	75	75	75	75	75	75	75	---	75	**	75	75	75	---
	Chloride ion, max. percent	0.10	0.10	0.15	0.10	0.30	0.15	0.10	0.30	0.30	**	---	0.15	0.15	---
	Shrinkage, max. percent; based 4 x 4 x 11 inch specimen														
	Laboratory	0.036	0.036	0.048	---	---	0.048	0.048	---	0.048	**	---	---	0.048	---
	Field	0.048	0.048	0.064	---	---	0.064	0.064	---	0.064	**	---	---	0.064	---
	Coarse Aggregate: Clay and shale combined particles shall not exceed, max. percent	1	1	1	1	1	3	2	10	1	**	3	1	2	3
10	**Concrete temperature at time of delivery and placement, max. °F**	85	85	90	85	90	95	85	95	95	**	90	85	85	95

NOTES:

* "D2" (Underwater concrete) - Limit aggregate to 3/4" for reinforced concrete, up to 1-1/2" for unreinforced concrete.

** "D3" (Mass Concrete) limiting requirements shall be as indicated in the Mass Concrete section.

[a] "D5" Wash water trough top edge water-cementitious ratio, 100 percent sand passing No. 8 sieve.

TABLE 2A – SUBMITTAL REQUIREMENTS (PRELIMINARY REVIEW OF MATERIALS)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1	**Aggregate reports** (ASTM C33)														
	Fine aggregate														
	Source and type	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Gradation	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Deleterious materials	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Fineness modulus	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	X	X	X	X	X	X	**	---	X	X	X
	Sand equivalent	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Coarse aggregate														
	Source and type	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Gradation	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Deleterious materials	X	X	X	---	X	X	X	X	X	**	X	X	X	---
	Abrasion loss	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Soundness test	X	X	X	---	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	---	X	X	X	X	X	**	---	X	X	X
	Combined aggregate gradation	X	X	X	---	X	X	X	X	---	**	X	---	---	---
2	**Cement**, mill report	X	X	X	X	X	X	X	X	X	**	X	X	X	X
3	**Cementitious material**, type, data sheet, and test report (fly ash, slag cement)	X	X	X	X	X	X	X	X	X	**	X	X	X	X
4	**Admixtures**														
	Data sheets and certifications	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Manufacturer's approval letter	X	X	X	X	X	X	X	X	X	**	X	X	X	X

TABLE 2B – SUBMITTAL REQUIREMENTS (PROPOSED MIXTURE PROPORTIONS)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
5	**Mixture proportions**, reports	X	X	X	X	X	X	X	X	X	**	X	X	X	X

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
6	**Type of testing**														
	Field test records acceptable	---	---	---	---	---	---	---	X	---	**	X	X	X	X
	Trial mixtures required	X	X	X	X	X	X	X	---	X	**	---	---	---	---
7	**Test Reports Required**														
	Confirmation of materials tested														
	Cement brand, type, composition, quantity	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Fly ash brand, type, composition, quantity	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Specific gravity of each aggregate	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Ratio of fine to total aggregates	X	X	X	---	X	X	X	---	---	**	---	X	X	---
	Water content	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Water-cementitious materials ratio	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Slump	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Unit weight	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Air content	X	X	X	---	X	X	X	---	---	**	---	X	X	---
	Temperature	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Time of initial set at 70°F and 90°F.	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Three point curves	X	X	X	---	---	---	X	---	X	**	---	---	---	---
	Compressive strength at 7 and 28 days	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Water-soluble chloride ion	X	X	X	X	X	X	X	X	X	**	---	X	X	---

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
	Drying shrinkage	**X**	**X**	**X**	**---**	**---**	**X**	**X**	**---**	**X**	******	**---**	**---**	**X**	**---**

NOTES:
** "D3" (Mass Concrete) submittal requirements shall be as indicated in the Mass Concrete section.

End of Section

Section 03 30 13

CONCRETE PLACING

PART 1 – GENERAL

1-1. SCOPE. This section covers placing of cast-in-place concrete.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1-2. GENERAL. All cast-in-place concrete shall be properly placed as indicated on the Drawings and as specified herein.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. All submittals of test data, manufacturers' certificates of compliance, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

1-3.02. Manufacturer's Certificate of Compliance. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to the Structural Engineer of Record for the following materials:

Epoxy bonding agent.

1-3.03. Lift Drawings. Concrete lift drawings shall be submitted in accordance with the Submittals Procedures section. Content of the lift drawings shall include, but not be limited to, the following.

Construction joint locations and pour sequences.

Concrete dimensions, joint details, and location of embedded items required by electrical, mechanical, and electrical design.

Location of any blockouts required where needed to work around late delivery of items to be embedded.

PART 2 - PRODUCTS

2-1. LIMITING REQUIREMENTS. Concrete shall be handled and placed in a manner that will minimize shrinkage and cracking as specified herein. Concrete temperatures shall be controlled both before and after placement to minimize cracking.

2-2. MATERIALS.

Epoxy Bonding Agent	ASTM C881, Type V, moisture insensitive, 100 percent solids; Dayton Superior “Sure Bond J58”, Euclid "Euco #452", or Prime Resins “Prime Bond 3000”.

2-3. ARCHITECTURAL CONCRETE. Not used.

PART 3 - EXECUTION

3-1. RECEIVING. Design-Builder shall check each delivery ticket to verify the concrete class delivered to the jobsite is in compliance with the concrete requested and is suitable for Design-Builder's handling, placing, finishing, and curing procedures. Owner’s Representative will collect the delivery tickets from the truck operator.

3-2. PLACEMENT. The limits of each concrete pour shall be determined by Design-Builder and shall be acceptable to the Structural Engineer of Record. All concrete within the predetermined limits shall be placed in one continuous operation.

Before concrete is placed, forms, reinforcement, water stops, anchor bolts, and embedments shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to the Structural Engineer of Record. Remove all frost, ice, and snow from within the formwork before concrete is placed.

Design-Builder shall inform the Structural Engineer of Record at least 48 hours in advance of any concrete placement.

3-2.01. Bonding to Hardened Concrete. The surface of hardened concrete upon which fresh concrete is to be placed shall be rough, clean, sound, and damp. Before placement of plastic concrete, the hardened surface shall be cleaned of all laitance and foreign substances (including curing compound), washed with clean water, wetted thoroughly, and the surface made free of standing water. Surface profile of the hardened concrete after surface preparation shall be as required for good bond.

Coarse aggregate shall be omitted from the first batch or batches of concrete placed on hardened concrete in wall or column forms. The mortar puddle, Class A4 concrete, shall cover the hardened concrete by at least 2 inches [50 mm] at every point.

3-2.02. Conveying Concrete. Methods of conveying concrete to the point of final deposit shall prevent segregation or loss of ingredients. After placement in the forms, concrete shall not be moved laterally more than 5 feet [1500 mm]. Concrete's free fall should not exceed 4 feet [1200 mm].

3-2.03. Pumping Concrete. The slump of concrete, with or without a superplasticizer, which is discharged into the pump may exceed the specified maximum slump value by the amount of slump loss in the pumping system, up to a maximum of 1 inch [25 mm]. The slump loss shall be determined by tests made at each end of the pumping system. If tests indicate a slump loss greater than 1 inch [25 mm] in the pumping system, Design-Builder shall modify the pumping system as required to reduce the slump loss to 1 inch [25 mm] or less.

3-2.04. Placing Concrete. For proper compaction, concrete shall be placed in approximately horizontal layers not to exceed 24 inches [600 mm]. Each layer of concrete shall be plastic when covered with the following layer, and the rate of vertical rise of the concrete in the forms shall not be less than 24 inches [600 mm] per hour. Vertical construction joints shall be provided as necessary to comply with these requirements.

Concrete shall be placed and compacted in wall or column forms before any reinforcement is placed in the system to be supported by such walls or columns. The height of any portion of a wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet [1800 mm]. Concrete in walls or columns shall be in place at least 2 hours before concrete is placed in the structural systems to be supported by such walls or columns.

Concrete shall be thoroughly settled in wall forms before top finishing. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.

Concrete for piers or caissons shall be carefully deposited to avoid contact with forms, reinforcement, and earth sides until completion of the drop. Necessary precautions shall be taken during concrete placement to prevent earth or other material from falling into excavations and to avoid dislocation of reinforcement. Concrete shall be placed continuously to the top of each pier or caisson at a rate of not less than 2 feet [600 mm] of vertical rise per hour. Forms above grade shall be of cylindrical steel or fiber acceptable to the Structural Engineer of Record.

3-2.05. Compaction. During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcement and embedments and into the corners of the forms. Mechanical vibrators shall maintain at least 14,000 cycles per minute when immersed in the concrete. The number and type

of vibrators shall be acceptable to the Structural Engineer of Record. The use of "jitterbug" tampers to compact concrete flatwork will not be permitted.

3-2.06. Cold Weather Concreting. Except as modified herein, cold weather concreting shall comply with ACI 306.1.

When placed, heated concrete shall not be warmer than 80°F [26°C].

3-2.07. Hot Weather Concreting. Except as modified herein, hot weather concreting shall comply with ACI 305.1.

At air temperatures of 90°F [32°C] or above, concrete shall be kept as cool as practicable during placement. The temperature of the concrete when placed in the work shall not exceed the values indicated in the Cast-in-Place Concrete section.

Plastic shrinkage cracking due to rapid evaporation of moisture shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 lb per square foot per hour [1 kg/m^2/h], as determined using the nomograph in Appendix A of ACI 305.1.

3-2.08. Placement Sequence. To minimize the effect of shrinkage in producing cracks, the following structures shall be constructed using a placement sequence:

a. Treatment Area (BNR Basins and MBR System)
b. Residuals Area (Sludge Holding and SAFE Settle Tanks)

For these structures, concrete shall be placed as follows:

a. Bottom Slab. Each bottom slab shall be divided into sections by the construction joints indicated on the Drawings and, when not indicated on the Drawings, into approximately square sections not greater than 60 feet [18 m] in their longest dimension. Bottom slabs with radial and circumferential reinforcement patterns may be

divided into pie-shaped segments with the longest dimension not greater than 60 feet [18 m]. A section near the center of each structure shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of previously placed sections. Placement shall be scheduled so that two adjacent sides of each section are free, except at closures.

b. Walls. Walls shall be divided into sections by the construction joints indicated on the Drawings and, when not indicated on the Drawings, into sections not greater than 60 feet [18 m] in length. A section

near the center of each wall shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of the previously placed section. Placement shall be scheduled so that one end of each section is free, except at corner closures.

c. Top Slab. Each top slab shall be placed in the manner described for the bottom slab.

No two abutting sections shall be placed within a period of 48 hours, unless otherwise authorized by the Structural Engineer of Record.

3-2.09. Duct Banks. Duct bank concrete shall be compacted by rodding or spading only. Mechanical vibrators shall not be used. Concrete shall be worked around reinforcement and embedments and into the corners of the forms.

3-3. PAN STAIRS. Not used.

3-4. COMPOSITE TOPPING CONCRETE. Composite topping concrete (Class D6) shall be placed in the locations indicated on the Drawings.

3-4.01. Surface Preparation. Before topping is applied, the underlying hardened concrete surface shall be scrubbed clean. Grease or oil shall be completely removed by cleaning the surface in accordance with ASTM D4258 and abrading the surface in accordance with ASTM D4259 by chipping or grinding. The cleaned surface shall be rinsed with clean water and kept saturated for the 24 hour period immediately preceding the application of topping. Immediately before topping is applied, the hardened concrete shall be coated with epoxy bonding agent or with neat portland cement slurry having the consistency of paint.

3-4.02. Composite Topping. Composite topping concrete shall be applied over the precast or cast-in-place concrete roof areas indicated on the Drawings. Topping shall be spread and compacted with suitable concrete tools. Topping shall be accurately placed to the elevations and slopes indicated.

3-5. CLEANING EMBEDMENTS. Embedments shall be clean when installed.

End of Section

Section 03 35 00

CONCRETE FINISHING

PART 1 – GENERAL

1-1. SCOPE. This section covers finishing of cast-in-place concrete.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1-2. GENERAL. All cast-in-place concrete shall be properly finished as indicated on the Drawings and as specified herein.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. All submittals of test data, manufacturers' certificates of compliance, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

1-3.02. Manufacturer's Certificate of Compliance. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted for the following materials:

Floor sealer.

PART 2 - PRODUCTS

2-1. MATERIALS.

Concrete Surface Coloring/Hardener	Mineral aggregate dry-shake colored hardener for concrete flatwork. ChemSystems, Inc. “CSI Heavy-Duty Color Hardener”, Euclid “Surflex”, or Dayton Superior “Quartz Tuff”.
Evaporation Reducer	Dayton Superior "AquaFilm Concentrate J74", Euclid "Eucobar", L&M Chemical "E-Con", BASF "MasterKure ER50", or Sika "SikaFilm".
Nonslip Aggregate	Not used.

Floor Sealer	ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, non-yellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

PART 3 - EXECUTION

3-1. FINISHING UNFORMED SURFACES. Buried and permanently submerged concrete blocking and encasement will require no finishing except as necessary to obtain the required surface elevations or contours. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

3-1.01. Screeding. Screeding shall produce a concrete surface conforming to the proper elevation and contour, with all aggregates completely embedded in mortar.

3-1.02. Application of Evaporation Reducer. Concrete flatwork subject to rapid evaporation due to hot weather, drying winds, and sunlight shall be protected with an evaporation reducer. The evaporation reducer shall form a continuous film on the surface of fresh, plastic concrete to reduce evaporation.

Immediately following screeding, evaporation reducer shall be sprayed over the entire surface of fresh, plastic concrete flatwork at a rate of not less than 200 square feet per gallon [4 m^2/L], in accordance with the manufacturer's recommendations. The spray equipment shall have sufficient capacity to continuously spray the product at approximately 40 psi [275 kPa] with a suitable nozzle as recommended by the manufacturer.

The sprayable solution shall be prepared as recommended by the manufacturer.

Under severe drying conditions, additional applications of evaporation reducer may be required following each floating or troweling, except the last finishing operation.

3-1.03. Floating. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color, and unless additional finishing is specifically required, shall produce the completed finish for unformed surfaces.

Floating shall be done with hand floats or suitable mechanical compactor-floats.

3-1.04. Finishing Surfaces for Bonding. All surfaces to be covered with concrete or topping shall be float finished. All laitance, surface mortar, and unsound material shall be removed by brushing or air blasting at the time of initial set. Surfaces shall be rough, clean, and sound. Floors and other flat surfaces to receive composite topping (Class D6) shall be given a broom finish or raked finish with at least a 1/4 inch profile.

3-1.05. Troweling. Interior floor surfaces which will be exposed after construction is completed; surfaces to be covered with resilient floor coverings, thinset terrazzo, or seamless floor covering; exposed top surfaces of equipment bases and interior curbs; and other surfaces designated on the Drawings shall be steel trowel finished. Surfaces to be covered with elastomeric deck covering shall be lightly troweled but not burnished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

3-1.06. Edging. Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having at least a 1/8 inch [3 mm] corner radius.

3-1.07. Broom Finish. Not used.

3-1.08. Nonslip Aggregate Finish. Not used.

3-1.09. Pavement Finishing. The surface of pavements shall not vary more than 1/8 inch [3 mm] under a 10 foot [3 m] straightedge placed parallel to the center line.

Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be drag finished, using a seamless strip of damp burlap over the full width of the surface. The burlap drag shall consist of sufficient layers of burlap and shall have sufficient length in contact with the concrete to slightly groove the surface. The drag shall be moved forward with a minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. When acceptable to Design-Builder, carpet, artificial turf, or cotton fabric may also be used.

Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be broom finished with a broom acceptable to Design-Builder. The broom shall be not less than 18 inches [460 mm] wide and made from good quality bass or bassine fibers not more than 5 inches [125 mm] long. The broom finishing shall produce regular corrugations not over 1/8 inch [3 mm] deep. The broom shall be pulled square across the surface, from edge to edge, with adjacent strokes slightly overlapped, and shall not tear the concrete surface.

3-1.10. Curb and Gutter Finishing. Not used.

3-1.11. Sidewalk Finishing. Not used.

3-2. CONCRETE SURFACE COLORING/HARDENER. Where concrete surface coloring/hardener is required, a dry-shake coloring material shall be worked into the freshly screeded concrete surface.

3-2.01. Duct Bank Finishing. After screeding and before final floating, a red concrete surface coloring shall be dusted onto the fresh concrete surface at the rate recommended by the manufacturer.

3-2.02. Floor Finishing. Where concrete surface coloring/hardener is required on the Drawings, the coloring material shall be applied at the rate of 50 lbs per 100 square feet [244 kg/100 m^2] in strict accordance with the manufacturer's recommendations. The color of the concrete surface shall be as required on the Drawings.

Concrete floors with surface coloring shall be protected from damage until acceptance by Design-Builder. Areas which are subject to traffic or over which equipment or materials are to be moved shall be covered with hardboard or plywood. Just before final inspection, the colored floors shall be thoroughly cleaned and then waxed with colored wax furnished by the manufacturer of the coloring material.

3-2.03. Floor Polishing. At locations identified on the Drawings, concrete floors shall be polished after application of coloring/hardener to a uniform level of grind, producing a hard-shell satin (400 grit) final finish. Polish using diamond power disc machines and grind only to Level 1, achieving a "cream finish" without substantial aggregate exposure, and maintaining non-slip properties per ANSI B-101.1.

3-3. MINERAL COLORED CONCRETE. Not used.

3-4. FLOOR SEALER. All concrete floors in interior locations which are to remain as exposed concrete or will be covered with carpet shall be given two coats of clear floor sealer in addition to any which may have been applied as a membrane curing compound. Floor sealer shall not be applied to concrete floors that are to be stained or etched, covered with chemical resistant linings, covered

with additional concrete, or indicated in the Architectural drawings to be covered with a finish flooring material. Prior to application of each coat of sealer, the floor shall be thoroughly cleaned of dirt, grease, and other foreign matter. The first coat shall be applied at the end of the curing period and before any traffic is permitted on the floor. The second coat shall be applied in preparation for substantial completion of the work. Floor sealer shall be applied in accordance with the manufacturer's recommendations.

3-5. REPAIRING DEFECTIVE CONCRETE. Defective concrete shall be defined as any surface with undesirable visible effects in excess of that permitted by the relevant formed concrete surface category (CSC), except as indicated otherwise herein.

Defects in formed concrete surfaces shall be repaired to the satisfaction of the Structural Engineer of Record within 24 hours of form removal. Surface repair work shall conform to Article 5.3.7 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of the surrounding concrete. Surface repair material shall be adequately cured.

Defects in concrete that are more than 3 inches deep shall be brought to the attention of the Structural Engineer of Record prior to any repair work. Design-Builder shall submit a proposed repair material and procedure for review by the Structural Engineer of Record. The repair material and procedure required by the Structural Engineer of Record may be more extensive than the process described in Article 5.3.7 of ACI 301.

3-6. FINISHING FORMED SURFACES. Formed concrete surfaces shall meet all criteria of the relevant formed concrete surface category (CSC), as defined in ACI 347.3R, except as indicated otherwise herein. Surfaces shall be assigned to CSC's as indicated.

Formed Concrete Surface Category	Applicable Surfaces	Mockup Required
CSC1	Formed concrete surfaces that will be in permanent contact with earth backfill.	No
CSC2	All other formed concrete surfaces not designated otherwise.	No
CSC3	None.	Yes
CSC4	None.	Yes

3-6.01. Tie Holes. All tie holes in formed surfaces, regardless of the relevant CSC, shall be cleaned, wetted, and filled with patching mortar. The patches shall be finished flush and cured and shall match the texture and color of the adjacent concrete.

3-6.02. Mockups. Not used.

3-6.03. Grout Cleaning. Any exposed-to-view vertical faces of Operations Building foundations or other surfaces noted on the Drawings shall be finished by grout cleaning.

Grout-cleaned finish shall conform to Paragraph 5.3.3.4.b of ACI 301. Grout cleaning shall not result in an overall plastering of the concrete surfaces, but shall produce a smooth, uniform surface free of marks, voids, surface glaze, and cement dust.

3-7. TOLERANCES. Tolerances for cast-in-place concrete work shall be as stipulated in ACI 117, unless otherwise indicated.

3-7.01. Ringwall Tolerances. The top of the foundation ringwall for each steel reservoir shall be accurately constructed within the following tolerances:

a. In any 30 foot [9,000 mm] length, the top of the wall shall not vary from level by more than 1/4 inch [6 mm] peak to valley.

b. No two points on the top of the wall shall differ in elevation by more than 1/2 inch [12.5 mm].

Levels will be checked on the top of the foundation wall, and any variations exceeding the specified tolerances shall be corrected prior to erection of the reservoir.

3-8. CONCRETE WASH WATER TROUGHS. Not used.

3-9. PAN STAIRS. Not used.

3-10. COMPOSITE TOPPING CONCRETE. Not used.

3-11. CLEANING EMBEDMENTS. After placement of concrete, surfaces of embedments not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

End of Section

Section 03 39 00

CONCRETE CURING

PART 1 – GENERAL

1-1. SCOPE. This section covers curing of cast-in-place concrete.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1-2. GENERAL. All cast-in-place concrete shall be properly cured as indicated on the Drawings and as specified herein.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. All submittals of test data, manufacturers' certificates of compliance, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

1-3.02. Manufacturer's Certificate of Compliance. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to for the following materials:

Membrane curing compound.

PART 2 - PRODUCTS

2-1. LIMITING REQUIREMENTS. Concrete shall be cured in a manner that will minimize shrinkage and cracking as specified herein.

2-2. MATERIALS.

Membrane Curing Compound	ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, non-yellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

PART 3 - EXECUTION

3-1. GENERAL.

3-1.01. Cold Weather Concreting. Except as modified herein, cold weather concreting shall comply with ACI 306.1.

The concrete surface shall be maintained at a temperature of at least 50°F [10°C] for 5 days or 70°F [21°C] for 3 days, after placement. Concrete temperature shall be recorded at least six times for each 24 hour period. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

3-1.02. Hot Weather Concreting. Except as modified herein, hot weather concreting shall comply with ACI 305.1.

At air temperatures of 90°F [32°C] or above, concrete shall be kept as cool as practicable during curing.

Plastic shrinkage cracking due to rapid evaporation of moisture shall be prevented.

3-2. CURING. Concrete shall be protected from loss of moisture for at least 7 days after placement unless indicated otherwise. Curing of concrete shall be done by methods which will keep the concrete surfaces adequately wet for the specified curing period.

3-2.01. Water Curing. Water curing shall be performed for concrete in liquid-containing structures and for all concrete containing slag cement. Other forms of curing will not be acceptable in these applications. Water curing shall be in accordance with ACI 308.1 except as modified herein.

Water saturation of concrete surfaces shall begin as soon as possible after initial set. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

Water curing shall continue for 14 days for concrete containing slag cement, and for 7 days for other types of concrete. However, when concrete is being protected from low temperatures, the duration of water curing may be shortened to 1 day less than the duration of cold weather protection.

When forms are removed before the specified curing duration is completed, measures shall be taken to immediately continue water curing and to provide adequate thermal protection for the concrete.

3-2.02. Membrane Curing. Unless otherwise specified, membrane curing compound may be used instead of water curing on concrete in non-liquid-containing structures which will not be stained or etched, covered with chemical resistant linings, covered with additional concrete, or indicated in the Architectural drawings to be covered with a finish flooring material.

Membrane curing compound shall be evenly sprayed at a coverage rate of not more than 300 square feet per gallon [7.3 m^2/L]. The spray equipment shall have sufficient capacity to continuously spray curing compound at approximately 40 psi [275 kPa] with a suitable nozzle as recommended by the manufacturer. Unformed surfaces shall be covered with the first coat of curing compound within 30 minutes after final finishing. A second coat of curing compound shall be applied when the first coat has become tacky to the touch and shall be applied at right angles to the first coat.

Curing compound shall be suitably protected against abrasion during the curing period.

3-2.03. Film Curing. Unless otherwise specified, film curing with white polyethylene sheeting may be used instead of water curing on concrete in non-liquid-containing structures which will be covered later with mortar or additional concrete, or which will otherwise not be exposed to view.

Film curing shall begin as soon as possible after initial set of the concrete. The concrete surfaces shall be completely covered with polyethylene sheeting. Sheeting shall overlap the edges of the concrete for proper sealing and anchorage, and joints between sheets shall be sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and as necessary to prevent billowing on the surface.

End of Section

Section 03 60 00

GROUTING

PART 1 - GENERAL

1-1. SCOPE. This section covers procurement and installation of grout. Unless otherwise specified, only nonshrink grout shall be furnished.

Epoxy grouting and adhesive anchoring of anchor bolts, threaded rod anchors, and reinforcing bars is covered in the Anchorage in Concrete and Masonry section. Grouting of masonry is covered in the Masonry section.

1-2. SUBMITTALS. A letter of certification indicating the types of grout to be supplied and the intended use of each type shall be submitted in accordance with the Submittals Procedures section.

1-3. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent damage of any kind. Materials shall be protected from moisture.

PART 2 - PRODUCTS

2-1. MATERIALS.

Nonshrink Grout	Precision cementitious grout with demonstrated non-shrinking properties, minimum 28 day compressive strength of 9000 psi; L&M "Crystex", BASF "Masterflow 928”, Sika “SikaGrout 328”, or Dayton Superior "Sure-Grip High Performance Grout".
Water	Clean and free from deleterious substances.

2-2. CEMENTITIOUS GROUT. Cementitious grout shall be furnished factory premixed so that only water is added at the jobsite.

2-3. EPOXY GROUT. Epoxy grout shall be used in lieu of cementitious grout when required by the equipment manufacturer for performance or warranty requirements. Epoxy grout shall be a three component system consisting of a Part A (resin), Part B (hardener) and Part C (aggregate). All three components shall be products of the same manufacturer and be compatible. Epoxy grout products and installation procedures shall be submitted to the Structural Engineer of Record for approval.

PART 3 - EXECUTION

3-1. CEMENTITIOUS GROUT INSTALLATION.

3-1.01. Preparation. The concrete foundation to receive cementitious grout shall be saturated with water for at least 12 hours preceding grouting unless additional time is required by the grout manufacturer.

3-1.02. Mixing. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout, nor shall water content exceed the amount recommended by the manufacturer.

3-1.03. Temperature Restrictions. Grout shall be placed in accordance with the manufacturer's published temperature restrictions. Ambient temperature and grout temperature shall be a minimum of 40 degrees F and rising at time of placement. Grout shall not be placed on frost covered surfaces. Grout shall be protected from freezing until it has reached a minimum strength of 4,000 psi. Grout shall not be placed when the ambient or grout temperature exceeds 90 degrees F.

3-1.04. Placement. Unless otherwise specified or indicated on the Drawings, grout under baseplates shall be 1-1/2 inches [38 mm] thick. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the baseplates are completely filled without voids. Forms shall be provided where structural components of baseplates will not confine the grout.

3-1.05. Edge Finishing. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate.

3-1.06. Curing. Grout shall be protected against rapid loss of moisture by covering with wet cloths or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 3 days and then an acceptable membrane curing compound shall be applied.

3-2. EPOXY GROUT INSTALLATION.

Epoxy grout shall be installed in accordance with ACI 351.5.

End of Section

Section 04 00 00

MASONRY

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and installing of building masonry. Ceramic tile and masonry water-repellant or stain coatings are covered in other sections.

1-2. GENERAL. Building masonry shall be constructed of units of the types, dimensions, arrangements, and coursing indicated on the Drawings and specified herein, complete with all materials, accessories, and appurtenances indicated and specified.

All work shall be in accordance with ACI 530.1 except as modified herein.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

All masonry units shall be handled in a manner which will prevent soiling, chipping, or damage of any kind. Broken, discolored, chipped, or otherwise damaged facing units will be rejected and shall be replaced with undamaged units.

Masonry units shall be stored on pallets, shall be protected against contamination and staining, and shall be kept covered and dry at all times. Lime and cement shall be stored under cover in a dry place.

Sand shall be stored so that the inclusion of foreign materials is prevented. Whenever sand is piled directly on the ground, the surface beneath the sand shall be smooth, well drained, and free from dust, mud, and debris. The bottom 6 inches [150 mm] of each pile shall not be used in mortar.

Insulation shall be stored under cover in a dry place, and shall be protected from the weather at all times.

1-4. SUBMITTALS. Before masonry construction is begun, the following drawings, data, specimens, and samples shall be submitted in accordance with the Submittals Procedures section. Additional data shall be submitted as needed. If the source of a material is changed during the course of the work, the tests and reports required for preliminary review of that material shall be resubmitted.

Recycled Content: Documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.

Regional Materials: Documentation indicating location and distance from project of material manufacturer and point of extraction, harvest or recovery for each regional material and the fraction by weight that is considered regional.

Specimens and color selection kits for all masonry units which will be used in the Work, showing range of colors, textures, finishes, and dimensions. Brick colors shall be submitted from at least five manufacturers.

Samples of all masonry units and mortar. At least two samples of each type of unit required shall be submitted.

Color selection sample kits for integral mortar colors.

One sample, at least 6 inches [150 mm] long, of each type of non-masonry joint material required.

Control joint locations in the CMU wall.

Shop drawings or manufacturers' literature showing details of anchors, ties, and metal accessories to be used in masonry construction.

Bar lists and drawings for the fabrication and placement of reinforcement with sufficient elevations and sections to adequately detail and label all reinforcement.

Cold and hot weather construction procedures.

Certificates for the following materials used in masonry construction, indicating compliance with the standards herein.

Masonry units.

Mortar and grout materials, including manufacturer data for any admixture, mortar coloring, or other product added to the grout or mortar.

Reinforcement.

Anchors, ties, fasteners, and metal accessories.

For each mortar mix, submit mix designs indicating type and proportions of ingredients in compliance with the proportion specification of ASTM C270.

For each grout mix, submit one of the following:

Mix designs indicating type and proportions of ingredients in compliance with the proportion by volume requirements of ASTM C476.

Mix designs indicating type and proportions of ingredients in compliance with the specified compressive strength method of ASTM C476.

1-5. COLOR SELECTION AND SAMPLE PANELS. Colors of masonry units and colored mortar will be selected from manufacturer's data and samples after the award of the contract.

1-5.01. Masonry Units. Colors for integral colored masonry units shall be selected from manufacturer's standard commercial color selections. Different colors may be required for each type of masonry unit or for different locations of the same type of masonry unit. Special color patterns shall be as indicated on the Drawings. General color selections shall be made from manufacturer's data. The preliminary color and texture selections shall be made prior to submitting the full size units and constructing the sample panels specified herein. All color, shade, and texture selections shall not be final until the field constructed sample panel has been accepted.

1-5.02. Marble and Granite. Not used.

1-5.03. Limestone. Not used.

1-5.04. Glass Block. Not used.

1-5.05. Mortar Coloring. Integral mortar color will be selected from sample kits submitted. After general color selections have been made, mortar samples shall be prepared for color selection. As many samples as are necessary to make a proper selection shall be prepared. Preliminary color selections shall be used in constructing the sample panels. Mortar colors shall not be final until the sample panels have been accepted.

1-5.06. Sample Panels. Before the installation of any masonry materials, sample panels shall be constructed at the Site incorporating each type of masonry material. Sufficient number of sample panels shall be constructed to show each type of exterior and interior wall configuration and bonding patterns indicated on the Drawings. Unless otherwise indicated or detailed on the

Drawings, sample panels shall be 6'-8" [2.0 m] long by 4'-0" [1.2 m] high. Sample panels shall show the proposed color range, texture, bonding patterns, mortar joints, mortar color, and workmanship for masonry materials. Each panel shall be of the thickness indicated on the Drawings for building walls of similar construction. The panels shall be representative of each typical exterior and interior masonry wall construction indicated on the Drawings complete with, as applicable, masonry units, bonding patterns, joint reinforcement, wall ties, wall insulation, vertical steel, a typical bond beam, mortar color, mortar tooling, weeps, and flashings. Each sample panel shall include a typical control joint complete with filler strips and caulking as indicated on the Drawings. The sample panels may be incorporated into the work if approved. No masonry work shall progress until Engineer has accepted the sample panels. The panels shall then become the standard of comparison for all masonry work built of the same materials. The panels shall not be destroyed or moved until all masonry work is completed.

At least one exterior wall panel shall include an exterior corner condition and an intersecting interior wall constructed as detailed on the Drawings.

1-6. BRICK ALLOWANCE. Not used.

1-7. COMPRESSIVE STRENGTH DETERMINATION. The compressive strength of CMU shall be determined by the unit strength method specified in ACI 530.1.

The design compressive strength of CMU, f'_m, for this project is 2500 psi.

CMU construction shall not begin until Engineer has reviewed the applicable submittals for strength of masonry units, grout, and mortar.

PART 2 - PRODUCTS

2-1. MATERIALS. All acceptable masonry products are indicated below. Products necessary for the work are as specified or as indicated on the Drawings. Sizes of masonry units are nominal, the actual size being slightly smaller to allow for mortar joints.

Concrete block	ASTM C90, 8 inch x 8 inch x 16 inch [200 mm x 200 mm x 400 mm], 6 inch x 8 inch x 16 inch [150 mm x 200mm x 400 mm], or 12 inch x 8 inch x 16 inch [300mm x 200mm x 400mm] face dimensions, sizes with special shapes as indicated on the Drawings; lightweight or standard weight aggregate conforming to ASTM C331 or ASTM C33, respectively.
Regular type	Standard gray color, sizes, special shapes, and face pattern as indicated on the Drawings. Standard weight aggregate units.
Burnished face type	Integral color units as indicated on the Drawings, mechanically ground face; full face, with special units as indicated on the Drawings.
Color	Mulitcolor, based on Air Vol #82B59804B.
Texture	Flat burnished face.
Scoring	Shallow concave.
Bonding pattern	Running bond, unless otherwise noted.
Special Shapes	Cap block: 2 inch x 8 inch x 16 inch precision units as indicated on the Drawings, Air Vol color #60-101.
Mortar	ASTM C270, cement-lime, Type S.
Sand	Natural sand in accordance with ASTM C144.
Portland Cement	ASTM C150, Type I.
Hydrated Lime	ASTM C207, Type S.
Quicklime	ASTM C5, pulverized.
Lime Putty	Quicklime, thoroughly slaked and stored for one day; kept moist until used.
Integral Mortar Color	ASTM C979, mineral pigments, natural or synthetic iron oxides, sun fast and water resistant, free of fillers and extenders. Soloman Grind-Chem Service, Inc. "A", "H", or "X" series.

False Joint Mortar	ANSI A118.4, Type S, Portland cement mortar with latex admixture, color to match mortar color.
Integral Waterproofing	Aluminum stearate, ammonium stearate, or calcium stearate, 2 percent of weight of cement; W. R. Grace "Dry Block Mortar Admixture", A. C. Horn "Hydratite", or Sonneborn "Hydrocide".
Grout	ASTM C476, conventional coarse grout.
Portland Cement	ASTM C150, Type I.
Sand	ASTM C404, natural sand.
Pea Gravel	ASTM C404.
Water	Clean and free from deleterious substances.
Prepared Joint Filler	ANSI A118.6 Sanded tile grout. Laticrete Series 500 joint filler, Bonsal "Sanded Grout" or Bostik "Hydroment Joint Filler".
Joint Reinforcement	Hohmann and Barnard; stainless steel, ASTM A580 Type 304; type as indicated on the Drawings with prefabricated corners and tees.
Ladder Type	Two-rod type.
Standard Weight	9 gage [3.80 mm thick] side rods and cross rods.
Heavy-Duty	3/16 inch [4.7 mm] side rods and 9 gage [3.80 mm thick] truss rods.
Thin Joint	11 gage [3.04 mm thick] side rods and cross rods.
Adjustable Type	Ladder type, 9 gage [3.80 mm thick] side rods and cross rods with 3/16 inch [75 mm] wire rectangular tabs and pintle ties at 16 inches [400 mm] on center.
Anchors and Ties	
CMU Wall Ends to Concrete	Dovetail anchor system.
Anchors	Corrugated anchor, 12 gage, 1 inch wide, punched or notched or mortar grip; length 16 inches or as indicated on the drawings. AISI Type 304 stainless steel.

Slots	22 gage, AISI Type 304 stainless steel, with fillers.
CMU Wall Ends to Structural Steel	Slotted channel anchors; Heckman or Hohmann & Barnard, stainless steel, ASTM A580 Type 304.
Channels	16 gage [1.52 mm thick] steel channels; weld-on, built-in, or screw on type as necessary.
Anchors	12 gage x 1 inch wide [2.66 mm thick x 25 mm wide] anchor straps punched or notched for mortar grip, 16 inches [400 mm] long unless otherwise required.
CMU Wall Ends to Structural Steel	Adjustable wire anchors fabricated from 1/4 inch [6 mm] wire, galvanized in accordance with ASTM A153, Class B-2; continuous weld-on anchor rods, with 1/4 inch [6 mm] wire anchors where indicated on the Drawings.
Reinforcing Steel	ASTM A615, Grade 60, deformed.
Rebar Positioner	9 gage [3.80 mm thick] wire, sized for block thickness, single or double bar type, galvanized ASTM A153, Class B-2.
Structural Wall Preformed Control Joint Material	
Rubber	ASTM D2000, extruded rubber, Hohmann & Barnard “#RS Series”
PVC	ASTM D2287, PVC, Hohmann & Barnard “VS Series”.
Weep Vents	High density polyethylene (HDPE) weep vents measuring 2 5/8”x3 ½”x ½”, color to match mortar color; Mortar Net Weep Vent.
Detergent Masonry Cleaner	ProSoCo "Vana-Trol" or National Chem-Search "DC-6", unless otherwise recommended by the masonry unit manufacturer and accepted by Engineer.

Wall flashings are covered in the Sheet Metal section.

2-2. MORTAR. The use of masonry cement, mortar cement, or prebagged ingredients will not be acceptable.

2-2.01. Masonry Mortar. Masonry mortar shall be qualified in accordance with the proportion specifications of ASTM C270.

2-2.02. Integral Mortar Color. Integral mortar coloring shall be added to the mortar for masonry as specified herein. All other joints shall be standard gray mortar. Each mortar color shall be of consistent color throughout the Project.

Where indicated on the Drawings, latex modified joint grout for false joints in scored concrete masonry units shall be colored to match mortar color.

2-3. GROUT. Grout shall be proportioned in accordance with ASTM C476, either by volume in accordance with Table 1 or by the specified compressive strength method. Only enough water shall be added to produce a mixture which is flowable, but which will not show an excess of water when placed. Unless otherwise specified, grout shall have a slump ranging from 8 to 11 inches [200 to 275 mm].

PART 3 - EXECUTION

3-1. MORTAR.

3-1.01. Mixing. The method of measurement of all mortar ingredients shall be accurate and shall ensure definite and uniform proportions. All mortar ingredients shall be mixed on site. Mortar shall be machine mixed for at least 5 minutes and shall be used within 90 minutes after mixing. Mortar left when work is stopped shall be discarded. Remixing of mortar more than 90 minutes old with additional water, cement, or other materials will not be acceptable.

The integral mortar color manufacturer's mixing instructions and proportions shall be strictly adhered to. Following the addition of integral mortar color, the mortar shall be mixed in a powered mixer until a uniform color is obtained, but not less than 5 minutes.

3-1.02. Jointing.

3-1.02.01. General. Masonry shall be laid in straight, level, uniform courses, with mortar joints of uniform width. Head joints shall approximately equal the horizontal joints in width.

Joints in masonry surfaces which are to be covered or not exposed shall be struck flush.

All exterior and exposed interior mortar joints, except joints in glazed materials, joints in walls which are to be covered, and joints which are to be raked, shall be tooled to a smooth uniform surface and shall be finished free of voids using a rounded tool. Mortar joints specified to be caulked shall be raked to a depth of 1/2 inch [12.7 mm]. Tooling of joints shall be regulated so that the mortar for each wall space has a uniform appearance.

The filling of masonry joints shall mean that the entire space between abutting surfaces of units is full, and that the body of the mortar is forced against and into the porous surface of each unit.

3-1.02.02. Brick. Not used.

3-1.02.03. Concrete Block. Abutting surfaces of head joints shall be completely and solidly cemented together with mortar.

Solid masonry units, starter courses for hollow units with vertical cells, hollow units with horizontal cells, and all units in masonry columns or pilasters shall be laid on a full bed of mortar.

All hollow CMU with vertical cells (above the starter course) shall be laid with face shell mortar bedding. In partially grouted walls, web joints of all cores which will be subsequently filled with grout fill shall be fully mortared. In fully grouted walls, web joints are not required to be mortared. All collar joints in multiwythe masonry walls, except cavity walls, shall be completely filled.

False joints in scored CMU shall be tuck pointed with latex portand cement mortar matching the bed mortar in color and texture. Joints shall be tooled as specified for regular joints.

3-1.02.04. Glazed Masonry. Not used.

3-1.02.05. Stone. Not used.

3-1.02.06. Marble and Granite. Not used.

3-1.02.07. Glass Block. Not used.

3-2. BONDING AND REINFORCING.

3-2.01. Bonding. Except where otherwise indicated on the Drawings, all concrete block shall be laid in running bond. Any special bonding patterns shall be as indicated on the Drawings.

3-2.02. Joint Reinforcing. Joints in horizontal masonry units shall be reinforced as specified, unless otherwise indicated on the Drawings.

The width of joint reinforcement (side rod to side rod) shall be approximately 2 inches [50 mm] less than the nominal overall thickness of the wall in which it is placed. All joint reinforcement shall be fully embedded in mortar and shall be covered with at least 5/8 inch [15 mm] of mortar on the exterior face

Joint reinforcing shall be discontinuous at control and expansion joints. The ends of sections of joint reinforcement shall be lapped at least 8 inches [200 mm] with the next section. At corners and intersections, prefabricated corner and tee reinforcing pieces shall be used.

3-2.02.01. Structural Glazed Tile. Not used.

3-2.02.02. Concrete Block. Mortar joints in concrete block shall be reinforced with continuous ladder type joint reinforcement spaced not more than 16 inches [400 mm] apart vertically. The joint reinforcement shall have one longitudinal rod at each face shell of the masonry units.

Cavity wall mortar joints shall be reinforced by means of continuous standard weight ladder type joint reinforcement spaced at 16 inches [400 mm] vertically. The reinforcement shall bridge the gap between the wythes of masonry.

Except where a top bond beam is indicated on the Drawings, the top three courses of all CMU walls, including backup, shall have continuous joint reinforcement placed in each joint (8 inch [200 mm] on centers). Openings in CMU walls shall have joint reinforcement placed in the two courses immediately above lintels and in the two courses immediately below all sills. Joint reinforcement shall extend 24 inches [600 mm] past openings on each side.

3-2.02.03. Brick Facing for Concrete. Not used.

3-2.03. Masonry Anchorage. Masonry anchorage to an abutting structure or to backup construction shall be as specified herein, unless indicated otherwise on the Drawings.

3.2.03.01. CMU Walls to Overhead Beams. Tops of CMU walls which abut the underside of steel or concrete beams shall be anchored to the beams as indicated on the Drawings.

3-2.03.02. CMU Wall Ends Terminating at Concrete. Unless indicated on the Drawings to be unconnected, ends of CMU walls which terminate at concrete columns or walls shall be anchored to the concrete by anchor slots cast in the concrete and dovetail anchors built into the CMU. Dovetail anchors shall be spaced 16 inches [400 mm] apart vertically. Dovetail anchors shall also be placed in each bond beam and in the course above and below each bond beam. Vertical cells of hollow CMU at each column or wall anchor shall be filled with grout.

3-2.03.03. CMU Wall Ends Terminating at Steel. Unless indicated on the drawings to be unconnected, ends of CMU walls which terminate at steel columns shall be securely anchored to the steel member with slotted channel anchors. Channels shall be welded to webs or flanges of columns, spaced and located to provide an adjustable anchor for each 16 inches [400 mm] of CMU wall height. Anchors shall also be placed in each bond beam and in the course above and below each bond beam.

Alternatively, CMU may be anchored by adjustable wire anchors. Anchor rods shall be welded to columns, spaced not more than 32 inches [800 mm] apart horizontally, and located to provide adjustable anchors at not more than 16 inches [400 mm] apart vertically in the CMU. Anchors shall also be placed in each bond beam and in the course above and below each bond beam.

3-2.03.04. Brick Veneer to CMU, Concrete, or Stud Wall Backup. Not used.

3-2.03.05. Stone Veneer to CMU or Concrete Backup. Not used.

3-2.03.06. Glass Block. Not used.

3-2.03.07. Stone Copings. Not used.

3-2.04. Reinforcing Steel. Concrete block bond beam units shall be installed and reinforced as indicated on the Drawings. Bond beam units shall be filled with grout fill as specified herein. Reinforcing steel shall be continuous around corners. At expansion joints, all bond beam reinforcing shall be discontinuous. At control joints, all bond beam reinforcing shall be continuous through the joint.

Vertically reinforced concrete block cores shall be provided as indicated on the Drawings. Reinforcing shall be accurately placed and securely tied to prevent shifting during core filling. Bar positioners shall be used for alignment. Positioners shall be placed in the bottom and top courses of walls and at not more than 4 feet [1,200 mm] centers between. Mortar fins which project into cores more than 1/2 inch [13 mm], and all loose mortar and debris, shall be removed before filling the cores. Cores shall be filled with grout fill as specified herein.

3-2.05. Grout. Unless otherwise acceptable to Engineer, grout shall be placed in lifts not to exceed 5 feet [1.5 m]. Lifts exceeding 12 inches [300 mm] in height shall be consolidated by mechanical vibration and reconsolidated after initial water loss and settlement. Bond beam grout shall not be mechanically vibrated. Grout shall be placed in reinforced block cores, bond beams, lintels, and in other locations indicated on the Drawings. If the cells beneath a bond beam are not required to be grouted, wire mesh material may be used in the joint to retain the grout.

3-3. LAYING MASONRY UNITS. All masonry units shall be free from dust, dirt, and surface moisture when laid. Concrete blocks shall be dry when laid.

All masonry shall be laid to a line. Walls shall be plumb and straight and in level courses. At no time shall any part of masonry construction project more than 8 feet [2.4 m] above adjacent work. When work is suspended, the tops of exterior masonry walls shall be covered and protected from the weather.

Care shall be taken in corner construction and at jambs to maintain uniformity of appearance and to ensure that only whole, undamaged units are used. All patterned masonry units shall have special corner units installed at exposed corners to maintain consistency of patterns. Masonry units shall be selected and laid so that the exposed face of each unit is free of broken corners, chipped edges, or other defects which would be detrimental to the appearance of the wall surface.

Units laid in stack bond or soldier coursing shall be carefully plumbed, so that vertical joints will form uniform, continuous vertical lines of uniform width, texture, and general appearance. Units shall be of uniform length and shall be trimmed as necessary.

Masonry units laid in running bond shall be so constructed that vertical joints in alternate courses lie in the same vertical lines, midway between the vertical joints in adjacent courses to provide a regular and uniform joint pattern. All custom scored units shall be aligned as detailed on the Drawings.

Masonry units shall be saw-cut to provide openings and to accommodate embedded items. Anchors shall be securely embedded in mortar. Door and window frames shall be maintained plumb and true. Masonry shall be built tightly against interior door frames. A caulking space shall be provided between exterior door frames and masonry in accordance with the details indicated on the Drawings. The jambs of built-in hollow metal door frames shall be completely filled with grout fill.

Lintels shall be provided over all CMU wall openings wider than the length of a masonry unit. Lintels shall be of the types and sizes indicated on the Drawings, and shall be acceptable to Engineer. Lintels longer than 3 feet [900 mm] shall bear on solid concrete masonry units or on grout-filled cells of hollow units at least one masonry course in height, unless otherwise indicated on the Drawings.

All embedded items shall be set and securely anchored in the masonry work as indicated on the Drawings or as acceptable to Engineer. Joints between masonry and embedded items shall be pointed.

Multi-wythe cavity walls shall be carefully constructed to the dimensions indicated on the Drawings. On the cavity face of both facing brick or other veneer and

concrete block all mortar extruded from the joints shall be struck off flush with the masonry surface. The cavity shall be kept free of mortar droppings.

Where indicated on the Drawings, the unfilled cores of concrete block or glazed block walls shall be filled with loose insulation. The insulation shall be poured into the space as the work progresses, with care taken to fill all spaces and voids.

3-4. THROUGH-WALL FLASHINGS. Through wall total flash flashing system shall be installed where and as indicated on the Drawings. Flashings in horizontal joints shall be in the bottom of the joints, and the stainless steel drip shall extend past the face of the wall unless otherwise indicated on the Drawings. Flashings shall drain toward the exterior surface of the wall. Lap joints shall be caulked and termination bars shall be screwed and caulked as per manufacturer's recommendations. The manufacturer's installation instructions shall be followed.

Flashings over lintels and sills shall extend 8 inches past each jamb and shall have end dams. Joints in wall flashings shall overlap and shall be caulked as per manufacturer's recommendations.

3-5. EXPANSION AND CONTROL JOINTS. Expansion and control joints in masonry walls shall be constructed as indicated on the Drawings. Joint material shall be placed tightly in the wall as construction proceeds.

Filler strips shall have a thickness not less than the nominal width of the joint. The filler strips shall be firmly bonded to one joint face by the adhesive backing, and shall be of required width to be held back 1/2 inch [13 mm] from each face for caulking, and placed under compression by the abutting masonry. All joints in filler strips shall be tightly butted.

3-6. ANCHORS, INSERTS, AND OTHER PENETRATIONS. All necessary ties, anchors, bolts, inserts, bucks, flashings, sleeves for piping, conduits of every kind, window and door frames, and other work shall be accurately set and securely held in the masonry work as indicated on the Drawings or in a manner acceptable to Engineer. Sleeves shall be provided where small piping passes through the masonry.

Structural shapes, joists, and decking passing through or over the masonry, but not bearing on the masonry, shall be isolated from the masonry by a minimum of 1 inch [25 mm] on all sides, unless indicated otherwise on the Drawings.

3-7. LOW TEMPERATURES. When the temperature of the surrounding air is below 40°F [4°C], the cold weather construction procedures of ACI 530.1 shall be followed except as modified below.

a. In addition to the weather protection specified for ordinary conditions, masonry materials shall also be kept from contact with snow, ice, or dampness of any kind.

b. The temperature of the mixed mortar shall be between 70 and 120°F [21 and 49°C]. Mixing water shall be warm, but not above 165°F [74°C]. If necessary, sand shall be heated also. Mortar mixing equipment shall be heated before it is used. The use of salt or calcium chloride is not acceptable.

c. Masonry units shall be above freezing when laid. If the outdoor temperature is below 30°F [-1°C]. units shall be heated to at least 40°F [4°C]. If the temperature is below 0°F [-17°C], units shall be heated to at least 60°F [15°C]. Heating shall be done so that the units are not damaged.

d. Masonry shall be kept warm for at least 72 hours after laying. The air temperature at the masonry surface shall be kept between 45°F and 90°F [7°C and 32°C], using heating methods that will not unduly dry out or otherwise damage the masonry. Masonry surfaces inside enclosures shall not be exposed to carbon dioxide gases emitted from heaters. Heat shall be applied to both sides of the wall, with provisions for proper circulation of air. The masonry shall be suitably housed or covered.

3-8. HIGH TEMPERATURES. When the ambient air temperature exceeds 100°F [38°C], or exceeds 90°F [32°C] with a wind velocity greater than 8 mph [13 km/hr], the hot weather construction procedures of ACI 530.1 shall be followed.

3-9. FINISH TUCK POINTING. On completion of the work, all exposed masonry shall be pointed where necessary and all voids and holes in the mortar shall be filled to match adjacent joint surfaces. Defective joints shall be cut out and re-pointed with mortar. Care shall be taken to produce a uniform overall appearance. Spottiness due to variations in either materials or workmanship will not be acceptable.

3-10. PAVING BRICK. Not used.

3-11. PROTECTION FROM DAMAGE. Masonry and all embedded or built-in items shall be carefully protected from damage. Masonry walls discolored by paint, mortar, or concrete shall be rebuilt with new materials.

Where concrete is placed adjacent to or on top of previously constructed masonry, the masonry shall be adequately protected against damage and against splashing of concrete paste.

3-12. CLEANING. Following finish pointing, all exposed masonry surfaces shall be cleaned to remove all surface stains and smears. If stains and smears cannot be removed by the specified methods, Contractor may propose alternative methods or cleaning products. These alternatives shall be acceptable to Engineer before they are used.

Mortar smears or droppings on concrete blocks shall be removed with a steel trowel after they have hardened to the extent that removal will not cause additional smearing. Any remaining mortar shall be removed to the extent possible by rubbing with a small piece of block. All surfaces shall then be thoroughly brushed.

3-13. OWNER'S FIELD CONTROL TESTING. Field control tests will be performed by Engineer or a testing laboratory. Contractor shall provide testing personnel with access to all material stockpiles and shall provide the services of one or more employees as necessary to assist with the collection of samples and construction of prisms. Contractor shall provide material samples in sufficient quantity to conduct the specified tests.

As stipulated in the Quality Control section, tests required during the progress of work will be made at the expense of Owner.

The frequency specified for each field control test is approximate and subject to change as determined by Engineer.

3-13.01. Clay Masonry Units. Not used.

3-13.02. Concrete Masonry Units. Concrete masonry units from worksite stockpiles will be tested once per 5,000 square feet [465 m^2] of wall. Sampling and testing will be in accordance with ASTM C140.

3-13.03. Grout. Grout will be field sampled during placement and will be tested once per 5,000 square feet [465 m^2] of wall. Sampling and testing will be in accordance with ASTM C1019. Compressive strength tests shall be conducted at 28 days after sample collection. Grout strength shall equal or exceed the specified f'_m.

3-13.04. Masonry Prism Tests. If the design compressive strength of masonry, f'_m, is determined prior to construction based on prism testing, then prism testing will be required for field verification in lieu of the preceding individual material tests. Prisms representative of the Project masonry will be constructed on Site using worksite stockpiles, and will be tested in accordance with ASTM C1314.

End of Section

Section 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions section, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Load-bearing wall framing.
2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
3. Ceiling joist framing.
4. Accessory bracing and furring required for a complete and proper installation.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, and connections used with cold-formed metal framing.
2. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated-Design Submittal: For cold-formed steel framing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Evaluation Reports: For nonstandard cold-formed steel framing, post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Consolidated Fabricators, Corp.

B. Approved equal.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, registered in California, to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As required for the imposed loads and in no case less than Code minimums.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
    a. Interior Load-Bearing Wall Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft.
    b. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft.
    c. Ceiling Joist Framing: Vertical deflection of 1/240 of the span for live loads and 1/240 for total loads of the span.
3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
    a. Upward and downward movement of 1 inch.
5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

A. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: As required by structural performance.
2. Coating: G90 or equivalent.

B. Steel Sheet for Vertical Deflection or Drift Clips: ASTM A653, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G90.

2.4 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0451 inch.
2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Metal Thickness: One gauge greater than steel studs.
2. Flange Width: 1-1/4 inches.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0451 inch.
2. Flange Width: 1-5/8 inches.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0451 inch.
2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: One gauge greater than steel studs.
2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Simpson Strong-Tie Co., Inc.

2. Approved equal.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.
2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

    a. Minimum Base-Metal Thickness: 0.0428 inch.
    b. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

2. Inner Track: Of web depth indicated, and as follows:

    a. Minimum Base-Metal Thickness: 0.0428 inch.

b. Flange Width: Sum of outer deflection track flange width plus 1 inch.

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0566 inch.
2. Flange Width: 1-5/8 inches, minimum.

2.7 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.8 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36, zinc coated by hot-dip process according to ASTM A123.

B. Anchor Bolts: As indicated in the Anchorage in Concrete and Masonry section.

C. Post-Installed Anchors: As indicated in the Anchorage in Concrete and Masonry section.

1. Uses: Securing cold-formed steel framing to structure.

2. Type: Expansion or adhesive anchors.
3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.9 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780.

B. Cement Grout: Portland cement, ASTM C150, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: As indicated in the Grouting section, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.10 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 07 20 00 "Building Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:

1. Anchor Spacing: To match stud spacing (24 inches max.).

B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch between the end of wall-framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:

1. Stud Spacing: 16 inches or As indicated on Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically as indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated on Drawings (24 inches maximum)..

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to studs and anchor to building structure.
4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at centers indicated on Shop Drawings but not more than 96 inches.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than 2 inches from abutting walls, and as follows:

1. Joist Spacing: As indicated on Drawings but not more than 24 inch centers.

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated on Shop Drawings but not more the 48 inch centers. Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.7 ERECTION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.8 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Design-Builder.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

End of Section

Section 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

This section covers the fabrication and installation of miscellaneous metal fabrications, including but not limited to the items listed in 1.2.

1.1 RELATED DOCUMENTS

A. Refer to Drawings and 01100 Section for additional information.

1.2 SUMMARY

A. Section Includes:
1. Steel framing and supports for ceiling-hung toilet compartments.
2. Steel framing and supports for operable partitions.
3. Steel framing and supports for overhead doors.
4. Steel framing and supports for countertops.
5. Steel tube reinforcement for low partitions.
6. Steel framing and supports for mechanic and electrical equipment.
7. Steel framing and supports for applications where framing and supports are not specified in other Sections.
8. Steel shapes for supporting elevator door sills.
9. Metal ladders.
10. Ladder fall protection safety systems.
11. Metal floor plate and supports.
12. Structural-steel door frames.
13. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.
14. Pipe and/or Downspout guards.
15. Abrasive metal nosings and thresholds.
16. Cast-iron wheel guards.
17. Metal downspout boots.
18. Clevises and Turnbuckles.
19. Eyebolts and Eyenuts
20. Welded headed studs.
21. Deformed bar anchors.
22. Bird screen.
23. Stop plates and grooves.
24. Basin effluent launders.
25. Basin/tank weir plates.
26. Scum baffles.
27. Metering weirs.
28. Bar screens.

29. Lime troughs.
30. Steel tanks and channels
31. Screw conveyors
32. Vortex grit equipment

B. Products furnished, but not installed, under this Section include the following: Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
C. Related Requirements:
   1. Structural Metals section.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Metal nosings.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
   1. Steel framing and supports for ceiling-hung toilet compartments.
   2. Steel framing and supports for operable partitions.
   3. Steel framing and supports for overhead doors and grilles.
   4. Steel framing and supports for countertops.
   5. Steel tube reinforcement for low partitions.
   6. Steel framing and supports for mechanical and electrical equipment.
   7. Steel framing and supports for applications where framing and supports are not specified in other Sections.
   8. Steel shapes for supporting elevator door sills.
   9. Metal ladders.
   10. Ladder fall protection safety systems.
   11. Metal floor plate and supports.
   12. Structural-steel door frames.

13. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.
14. Pipe and/or Downspout guards.
15. Abrasive metal nosings and/or thresholds.
16. Cast-iron wheel guards.
17. Metal downspout boots.
18. Clevises and Turnbuckles.
19. Eyebolts and Eyenuts
20. Welded headed studs.
21. Deformed bar anchors.
22. Bird screen.
23. Stop plates and grooves.
24. Basin effluent launders.
25. Basin/tank weir plates.
26. Scum baffles.
27. Metering weirs.
28. Bar screens.
29. Lime troughs.
30. Steel tanks and channels
31. Screw conveyors
32. Vortex grit equipment

C. Samples for Verification: For each type and finish of extruded nosing.

D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, registered in the State of California, to design ladders.

B. Structural Performance of Aluminum Ladders: Aluminum ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36.

C. Stainless-Steel Sheet, Strip, and Plate: ASTM A240 or ASTM A666, Type 316L.

D. Stainless-Steel Bars and Shapes: ASTM A276, Type 316L.

E. Rolled-Steel Floor Plate: ASTM A786, rolled from plate complying with ASTM A36 or ASTM A283, Grade C or D.

F. Rolled-Stainless-Steel Floor Plate: ASTM A793.

G. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.
   1. Harsco Industrial IKG.
   2. Ross Technology Corporation.
   3. W.S. Molnar Company.
   4. Alro Steel.
   5. Approved equal.

H. Steel Tubing: ASTM A500, cold-formed steel tubing.

I. Steel Pipe: ASTM A53, Standard Weight (Schedule 40) unless otherwise indicated.

J. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   1. Size of Channels: As indicated (1-5/8 by 1-5/8 inches minimum).
   2. Material: Galvanized steel, ASTM A653, structural steel, Grade 33, with G90 coating; 0.108-inch nominal thickness.
   3. Material: Cold-rolled steel, ASTM A1008, structural steel, Grade 33; 0.0966-inch minimum thickness; hot-dip galvanized after fabrication.

K. Cast Iron: Either gray iron, ASTM A48, or malleable iron, ASTM A47, unless otherwise indicated.

L. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.

M. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

N. Aluminum-Alloy Rolled Tread Plate: ASTM B632, Alloy 6061-T6.

O. Aluminum Castings: ASTM B26, Alloy 443.0-F.

P. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

Q. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

R. Nickel Silver Extrusions: ASTM B151, Alloy UNS No. C74500.

S. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

T. Forged Steel Clevises and Turnbuckles: AISI C-1035.

U. Forged Steel Eyebolts and Eyenuts: AISI C-1030, ANSI B 18.15 Type 2 shoulder pattern unless otherwise required.

V. Headed Concrete Anchors: ASTM A108 with a minimum 50,000 psi yield strength and minimum 60,000 psi tensile strength. TRW/Nelson or equal.

W. Deformed Bar Anchors: ASTM A496 with a minimum 70,000 psi yield strength and minimum 80,000 psi tensile strength. TRW/Nelson or equal.

X. Bird Screen: 2 mesh brass or copper wire cloth, minimum wire diameter 0.063 inch.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless-steel fasteners for fastening aluminum.
   2. Provide stainless-steel fasteners for fastening stainless steel.
   3. Provide stainless-steel fasteners for fastening nickel silver.
   4. Provide bronze fasteners for fastening bronze.

B. Not used.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A325, Type 3; with hex nuts, ASTM A563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 2.

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either

ASTM A47 malleable iron or ASTM A27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329.

H. Post-Installed Anchors: Torque-controlled expansion anchors or adhesive anchors, as specified in the Anchorage in Concrete and Masonry section.
   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
   2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with the General Equipment Stipulations section.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

H. Nonshrink, Nonmetallic Grout: As indicated in the Grouting section.

I. Concrete: Comply with requirements in the Cast-in-Place Concrete section.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings. Where continuous steel beam sizes are not indicated, contact Structural Engineer of Record for more information.

D. Galvanize miscellaneous framing and supports where indicated.

E. Prime miscellaneous framing and supports with primer specified in the General Equipment Stipulations section where indicated.

2.7 METAL LADDERS

A. General:
   1. Comply with ANSI A14.3, except for elevator pit ladders.
   2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:
   1. Space siderails as indicated on the Drawings.
   2. Siderails: Continuous, size and type as indicated on the Drawings.
   3. Rungs: Steel bars; size and shape as indicated on the Drawings.
   4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
      a. Manufacturers: Subject to compliance with requirements, provide products by the following:

1) Harsco Industrial IKG, a division of Harsco Corporation.
2) Approved Equal.

7. Support each ladder as indicated on the drawings with welded or bolted steel brackets.
8. Galvanize exterior ladders, including brackets.
9. Prime exterior ladders, including brackets and fasteners, with primer specified in the General Equipment Stipulations section.

C. Aluminum Ladders:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Halliday Products.
   b. O'Keeffe's Inc.
   c. Approved equal.
2. Space siderails as indicated on the Drawings.
3. Siderails: Continuous, size and type as indicated on the Drawings.
4. Rungs: Extruded-aluminum tubes, size and shape as indicated on the Drawings.
5. Fit rungs in centerline of siderails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
6. Support each ladder as indicated on the Drawings with welded or bolted aluminum brackets.
7. Provide minimum 72-inch-high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.8 LADDER FALL PROTECTION SAFETY SYSTEM

A. General:
1. Fall protection safety systems shall be OSHA approved.
2. Fall protection safety system shall consist of a carrier, safety sleeve, lanyard, and connectors, and be suitable for operation with a body harness. Body harness provided by Owner.
3. Fall protection safety system shall be 3M Lad-Saf system, or equal.

2.9 METAL FLOOR PLATE

A. Fabricate from rolled-steel floor plate, rolled-stainless-steel floor plate, rolled-aluminum-alloy tread, or abrasive-surface floor plate as indicated on the Drawings:
1. Thickness: As indicated on the Drawings.

B. Provide angle supports as indicated on the Drawings.

C. Include angle stiffeners, and fixed and removable sections as indicated on the Drawings.

D. Provide flush bar drop handles for lifting removable sections, one at each end of each section.

2.10 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
   1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize and prime steel frames.

D. Prime steel frames with primer specified in the Protective Coatings section.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize and prime miscellaneous steel trim.

D. Prime miscellaneous steel trim with primer specified in the Protective Coatings section.

2.12 PIPE AND/OR DOWNSPOUT GUARDS

A. Fabricate pipe and/or downspout guards from 3/8-inch-thick by 12-inch-wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

B. Galvanize and prime pipe and/or downspout guards.

C. Prime pipe and/or downspout guards with zinc-rich primer.

2.13 ABRASIVE METAL NOSINGS

A. Cast-Metal Units: Cast aluminum, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   1. Nosings: Cross-hatched units, 4 inches wide with 1-inch lip, for casting into concrete.
   2. Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches, for casting into concrete.

B. Extruded Units: Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
   1. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
   2. Provide solid-abrasive-type units without ribs.
   3. Nosings: Square-back units, 4 inches wide, for casting into concrete steps.
   4. Nosings: Beveled-back units, 4 inches wide with 1-3/8-inch lip, for surface mounting on existing stairs.
   5. Nosings: Two-piece units, 3 inches wide, with subchannel for casting into concrete steps.

C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

D. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
   1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.

E. Apply bituminous paint to concealed surfaces of cast-metal units.

F. Apply clear lacquer to concealed surfaces of extruded units.

2.14 CAST-IRON WHEEL GUARDS

A. Provide wheel guards made from cast-iron, 3/4-inch-thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.

B. Prime cast-iron wheel guards with primer specified in the General Equipment Stipulations section.

2.15 METAL DOWNSPOUT BOOTS (Not used.)

2.16 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with primer specified in the General Equipment Stipulations section.

2.17 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.18 STOP PLATES AND GROOVES

A. Stop plates shall be fabricated with the edges accurately finished. Plates shall be provided with suitable lifting handles and angle stiffeners as indicated on the Drawings. Each stop plate shall be permanently marked to identify its intended location.

B. Stop plate grooves shall be cast iron Neenah “Series R-7501” with all interior surfaces machined.

2.19 BAR SCREENS

A. Bar screens shall be fabricated from bars and shapes in accordance with the details indicated on the Drawings.

2.20 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.21 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153 for steel and iron hardware and with ASTM A123 for other steel and iron products.
   1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   1. Shop prime with universal shop primer.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
   1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   3. Items Indicated to Receive Primers Specified in the General Equipment Stipulations section: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.22 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for ceiling hung toilet partitions, operable partitions, overhead doors, and overhead grilles, as applicable, securely to, and rigidly brace from, building structure.

3.3 INSTALLING NOSINGS AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.4 INSTALLING CAST-IRON WHEEL GUARDS

A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

3.5 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.6 INSTALLING STOP PLATES AND GROOVES

A. Stop plate grooves shall be installed plumb and straight within a tolerance of 3/32 inch and with the opposite sides and bottom aligned in a single plane to prevent binding of the stop plate. If necessary to meet this requirement, a space shall be boxed out for guides, and the guides grouted in place later. Stop plates shall be set in place as needed for testing and startup procedures.

3.7 INSTALLING BASIN EFFLUENT LAUNDERS

A. Weir plates shall not be installed until after field painting of the effluent launders has been completed. Before installation of the weir plates, contact surfaces between weir plates and launders shall be given a heavy coat of sealant as specified in the caulking section.

3.8 INSTALLING BASIN WEIR PLATES

A. Before installation, surfaces in contact with concrete shall be given a heavy coating of sealant as specified in the caulking section. Weir plates shall be adjusted after installation to provide uniform overflow rate at all points.

3.9 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with

the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in the General Equipment Stipulations section.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

End of Section

Section 05 50 13

STRUCTURAL METALS

PART 1 - GENERAL

1-1. SCOPE. This section covers the fabrication and erection of structural metal items.

Except as otherwise specified or indicated on the Drawings, all work shall conform to the applicable provisions of the AISC "Steel Construction Manual" (14th edition) with the exception of the "Code of Standard Practice for Steel Buildings and Bridges"; and the Aluminum Association "Specification for Aluminum Structures".

Special inspection during the fabrication and erection of structural steel, if required by the local building code, is addressed in the Code-Required Special Inspections and Procedures section.

Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1-2. SUBMITTALS. Complete data, fabrication drawings, and setting or erection drawings covering all structural and miscellaneous metal items shall be submitted in accordance with the Submittals Procedures section.

All bolted connections and welds shall be properly identified on the shop drawings. Welding procedures, welding procedure qualification records and welder qualifications shall be submitted.

Submittals for high strength bolts, tension control bolts and load indicator washers shall include statements from the bolt and washer manufacturers certifying satisfactory compliance with the governing standards and the specified tests.

Submittals for items that are designed by the fabricator shall include drawings sealed by a professional engineer registered in the state of the project. Data shall include confirmation that the design meets all applicable code requirements. Calculations shall be submitted when requested by the Structural Engineer of Record.

1-3. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Structural and miscellaneous metal work shall be stored on blocking

so that no metal touches the ground and water cannot collect thereon. The material shall be protected against bending under its own weight or superimposed loads.

Bolting materials shall be stored indoors. Weld rod shall be stored in accordance with the supplier's instructions and AWS D1.1.

1-4. FABRICATOR QUALIFICATION. All fabricating plants providing structural steel shall be qualified fabricators who participate in the AISC Certification program and are designated an AISC Certified Plant, Category BU.

PART 2 - PRODUCTS

2-1. GENERAL. All materials needed for both shop and field assembly shall be furnished.

2-2. MATERIALS.

Steel

Shapes (W, WT)	ASTM A992.
Shapes (S, M, HP, C)	ASTM A36 or ASTM A572 Grade 50.
Other Shapes (angles)	ASTM A36.
Plates and Bars	ASTM A36.
Sheets	ASTM A1008 CS Type B or A1011 CS Type B.
Pipe	ASTM A53, Type E or S, Grade B (F_y = 35 ksi).
Round Structural Tubing	ASTM A500, Grade C (F_y = 46 ksi).
Square and Rectangular Structural Tubing	ASTM A500, Grade C (F_y = 50 ksi).

Bolts and Nuts

Bolts, High Strength	ASTM F3125, Grade A325.
Bolts, Tension Control Type (Twist off)	ASTM F3125, Grade 1852.

Bolts, unfinished	ASTM A307.
Nuts, Heavy-Hex	ASTM A563, grade and finish compatible with bolts.
Nuts, Self-Locking	Prevailing torque type; IFI-100, Grade A.
Washers	
Flat, Hardened	ASTM F436, Type 1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Beveled	ASTM F436.
Load Indicator	ASTM F959, compressible-washer-type direct tension indicator; type compatible with bolts tested in accordance with Article 10.2 of ASTM F959.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A36. Threaded rods shall have sufficient threading to permit the maximum adjustment available. Continuously threaded rod is not acceptable for rods over 12 inches in length.
Forged Steel Sleeve Nuts	AISI C-1018, Grade 2.
Stainless Steel	
Shapes	ASTM A1069 or A276, Type 316L.
Plates	ASTM A240, Type 316L.
Pipe	ASTM A312, Grade TP316L.
Tube	ASTM A269, Grade TP316L.
Checkered Plate	ASTM A793, Type 316L, raised pattern A.
Bolts	ASTM F593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.

Nuts	ASTM F594, Alloy Group shall match that of the bolts. Nuts shall have a minimum proof stress equal to or greater than the minimum full-size tensile strength of the bolts.
Washers	
Flat	ANSI/ASME B18.22.1, Type 316.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 316.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Aluminum	
Sheet and Plate	ASTM B209, Alloy 6061-T6.
Rolled Sections	ASTM B308, Alloy 6061-T6. All members shall be Aluminum Association standard shapes. Special shapes with sloping flange surfaces, or Army-Navy type members, shall not be used unless specifically indicated on the Drawings.
Rod and Bar (Rolled or Drawn)	ASTM B211, Alloy 6061-T6 or 2017-T4.
Extrusions	ASTM B221, Alloy 6063-T5 or T6.
Pipe	ASTM B429, Alloy 6061-T6.
Rivets	ASTM B316, Alloy 6061-T6.
Bolts, Aluminum	ASTM F468, Alloy 2024-T4.
Nuts, Aluminum	ASTM F467, Alloy 6061-T6.
Washers, Aluminum	
Flat	ANSI/ASME B18.22.1, Type 6061 T-6.

Lock	ANSI/ASME B18.21.1, helical spring type, Type 6061-T6.
Weld Metal (Steel Connections)	ANSI/AWS D1.1, Table 3.1, filler metal with minimum 70 ksi tensile strength unless otherwise required.
Rails	
Crane	ASTM A1.
Railroad	ASTM A1.
Shop Coatings	
Universal Primer	As indicated in the General Equipment Stipulations section.
Bituminous Paint	Metal fabricator's standard product.
Galvanizing	ASTM A123, A153, A385, and F2329 as applicable.

2-3. STAIRS. Stairs shall be fabricated to the dimensions, arrangements and sizes indicated on the Drawings. Stairs shall be true to line and slope, shall be rigidly supported, and shall be braced and tightened to prevent movement. All treads shall be level and in perfect alignment and spacing.

After installation, stairs shall be rigid and shall not sway noticeably or deflect under foot traffic. If necessary to prevent noticeable movement, additional supports or bracing shall be provided.

2-3.01. Stair Design. Stairs shall be designed by the stair supplier in general accordance with details indicated on the Drawings. The design shall comply with all applicable provisions of the local building code, ANSI A117.1, and OSHA as applicable. The drawings shall be sealed by a professional engineer registered in the state of the project. If requested, calculations shall be submitted to the Structural Engineer of Record.

The completed fabrications shall support a uniform live load of 100 lbs per square foot and a concentrated load of 300 lbs applied at the center of the span. Individual treads and platforms shall be designed to support a uniform live load of 100 lbs per square foot or a 300 lb concentrated live load applied on an area of 4 square inches. Vertical deflections under full live load shall be limited to span/240. Stairs and landings shall be braced or otherwise designed to avoid noticeable sidesway.

The stair design and details shall be coordinated with the handrailing and guardrailing supplied. Stair members shall be adequate to accept loads from the rail posts based upon the criteria in the Metal Railings section.

Connections between the stair members and the supporting structure shall be adequate to transfer all loadings, and shall be designed in accordance with all applicable provisions of the AISC manual and ACI 318 Chapter 17. The number and type of connections shall comply, at a minimum, with the Drawings. All necessary brackets, bolts, and anchors shall be provided.

2-3.02. Nosings. All stair treads shall have non-skid nosings, either fabricated integrally with the tread or attached with stainless steel bolts and self-locking nuts.

2-3.03. Grating Stairs. Treads shall be fabricated from grating material in accordance with the Metal Gratings section.

2-3.04. Pan Type Stairs. Risers and subtreads shall be fabricated from 12 USS gage steel and subplatforms from 10 USS gage steel. Fill depth shall be 2 inches for treads and 3 inches for platforms. Each riser shall have an integral non-slip nosing and a formed sanitary cove, located so that the toe of the cove will be at the surface of the concrete fill or applied finish.

2-3.05. Cast Aluminum Stairs. Risers and subtreads shall be fabricated from cast aluminum as indicated on the details on the Drawings.

2-4. CRANE SYSTEMS. Steel beams used as underhung crane or hoist runways shall be straight and level. The upper surface of the lower flange of each beam shall be smooth, with all projections ground off. Joints shall be close-fitting and free from unevenness. The beams shall be rigidly supported in exact alignment. A section of each runway beam shall not be installed until after the crane or hoist has been installed.

Stops as recommended by the crane or hoist manufacturer shall be bolted in place on each end of each runway beam to limit the travel of the crane or hoist. Stops shall be so located that the crane or hoist does not come into contact with any part of the structure or piping. If the crane or hoist is required to be powered, at the power feed end of the runway the stops shall be designed so that the cable trolleys will pass beneath the stops. The stops shall be so located that there is sufficient room on the runway for storage of the cable trolleys beyond the stops. Secondary stops shall be provided for the cable trolleys.

2-4.01. Crane Rails. Rails on which a traveling, top running crane is to travel shall be furnished complete with clamps or hook bolts, splice plates, stops, anchor bolts and nuts, and other accessories necessary to complete the installation indicated on the Drawings.

2-5. STRUCTURAL STEEL BOLTED CONNECTIONS. Bolt holes shall have a diameter nominally 1/16 inch larger than the nominal bolt diameter. Bolt holes for one ply of vertical diagonal bracing connections may be oversized to a diameter nominally 3/16 inch larger than the nominal bolt diameter.

2-6. SHOP COATING. All items shall be shop coated as specified herein. The requirements for field painting are covered in the General Equipment Stipulations section.

Contact surfaces of structural steel slip critical bolted connections shall not be shop coated. Contact surfaces of structural steel bearing type bolted connections may be shop coated.

2-6.01. Cleaning. Surfaces shall be dry and of proper temperature when coated, and shall be free of grease, oil, dirt, dust, grit, rust, loose mill scale, weld flux, slag, weld spatter, and other objectionable substances. Articles to be galvanized shall be pickled before galvanizing. All other ferrous metal surfaces shall be cleaned by solvent, high-speed power wire brushing or by blasting to the extent recommended by the paint manufacturer and as required in the General Equipment Stipulations section.

2-6.02. Edge Grinding. Sharp projections of cut or sheared edges of ferrous metals which will be submerged in operation, except for items specified to be hot-dip galvanized, shall be ground to a radius as needed to ensure satisfactory paint adherence and as required in the General Equipment Stipulations section.

2-6.03. Prime Painted Steel. Unless otherwise specified or indicated on the Drawings, all ungalvanized structural and miscellaneous steel shall be given a universal prime coat in the shop after fabrication. The dry film thickness of the universal primer shall be at least 5 mils. Steel surfaces shall be prime-coated as soon as practicable after cleaning. Steel shall not be moved or handled until the shop coat is dry and hard.

2-6.04. Galvanizing. Steel materials required to be galvanized are indicated on the Drawings. All galvanizing shall be done by the hot-dip process after fabrication. An approved zinc-rich paint shall be used to touch up minor coating damage, in accordance with ASTM A780. Materials with significant coating damage shall be regalvanized or replaced.

Bolts, nuts, and washers shall be galvanized when connected materials are galvanized or where indicated on the Drawings. The use of zinc-plated bolts will not be acceptable.

2-6.05. Stainless Steel. Unless otherwise specified, all items fabricated from stainless steel shall be thoroughly cleaned and degreased after fabrication. Pickling or a light blast cleaning shall produce a modest etch and remove all

embedded iron and heat tint. Surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron and shall be retreated as needed to remove all traces of iron contamination. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

2-6.06. Aluminum. All surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a coat of bituminous paint.

PART 3 - EXECUTION

3-1. STRUCTURAL STEEL ERECTION. Structural steel shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevations of the top of floor and roof members shall be within 1/16 inch of the elevations indicated on the Drawings. The faces of girts and other supporting members for rigid wall panels shall be in vertical planes within a maximum variation of 1/8 inch.

All members and parts, as erected, shall be free of warps, local deformations, and unauthorized bends. All parts shall be assembled accurately as indicated on the Drawings. Light drifting will be permitted to draw parts together, but drifting to match unfair holes will not be permitted. Any enlargement of holes necessary to make connections in the field shall be done by reaming with twist drills and only with the approval of the Structural Engineer of Record. Enlarging holes by burning will not be permitted.

Baseplates shall be set level in exact position and grouted in place.

3-1.01. Inspection and Testing. Special inspection will be performed as indicated in the Code Required Special Inspections and Procedures section. The erector shall provide access as needed to facilitate all inspections and shall provide timely notification during erection when inspection milestones are approaching.

3-1.02. Crane Rails. Crane rails shall be installed level and in accurate alignment and shall form a continuous, smooth track. Rail installation tolerances shall be in accordance with CMAA Specification 70.

3-2. STRUCTURAL STEEL BOLTED CONNECTIONS. Unless otherwise indicated on the Drawings, bolted connections for structural steel, as defined in the AISC manual, shall be made with ASTM F3125 high strength bolts conforming to the "Specification for Structural Joints Using High-Strength Bolts" as approved by the Research Council on Structural Connections. The method of installation, pretensioning procedures, bolting equipment and tools shall likewise conform to the above referenced standard.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts, or washers, shall be free of loose mill scale, dirt, burrs, oil, and other foreign material that would prevent solid seating of the parts.

Beveled washers shall be used when the bearing faces of bolted parts have a slope of 1:20 or greater with respect to a plane perpendicular to the bolt axis. Bolt length shall be increased as needed to accommodate the beveled washers.

If oversized holes are provided in an outer ply, a hardened flat washer shall be installed over each hole during bolting. Load indicator washers shall not be substituted for hardened flat washers required for oversized holes.

Tightening of each connection assembly shall progress systematically from the most rigid part of the joint toward the free edges until all have been sufficiently rotated or the load indicator washers on all bolts have been closed to the average gap stipulated by the load indicator washer manufacturer.

Except as otherwise indicated on the Drawings or specified herein, bolted connections shall be bearing type with threads excluded from the shear plane. Slip critical connections shall be used in diagonal bracing connections, where oversize holes or slotted holes parallel to the direction of the load are used, and where indicated on the Drawings.

Bolts in all structural steel connections, both bearing and slip critical, shall be fully pretensioned in accordance with the AISC standards unless specifically noted otherwise on the Drawings. The calibrated wrench method of pretensioning bolts will not be acceptable. Acceptable pretensioning methods are as follows:

Connection Type	Acceptable Pretensioning Method
Bearing	Turn of the nut method and load-indicator washers are acceptable. Tension control (twist-off) type bolts may be used only if approved by the Structural Engineer of Record.
Slip-Critical	Load indicator washers.

3-2.01. Turn of the Nut Method. The bolt, nut, and material shall be match marked. A wax lumber marker or paint shall be used to clearly mark the assembly.

3-2.02. Load-Indicator Washers. Load indicator washers shall be installed in accordance with the manufacturer's recommendations, as supplemented herein. To facilitate proper tightening of fastener assemblies with load indicator washers, a hardened flat washer shall be installed under the turned element (bolt head or nut) and between the turned element and the load indicator washer protrusions, in all cases. Whenever possible, the load indicator washer shall be installed on the head end of the bolt. If the bolt head will not be visible for inspection of the

indicator washer after installation, or if the bolt head must be turned to tighten the assembly, the load indicator washer may be installed on the nut end of the bolt.

3-2.03. Tension Control (Twist-off) Bolts. Patented tension control bolts shall be of equivalent size and strength to the indicated high strength bolts, and shall be installed in strict accordance with the manufacturer's instructions. Load-indicator washers are not required on tension control bolts.

3-3. STRUCTURAL, STAINLESS, AND MISCELLANEOUS STEEL WELDING. Welding and related operations shall conform to applicable provisions of AWS D1.1 for steel and AWS D1.6 for stainless steel. All welding shall be performed in accordance with written procedures, using only those joint details which have prequalified status. All welding shall be performed by welders qualified in accordance with the American Welding Society.

Welds not dimensioned on the Drawings shall be sized to develop the full strength of the least strength component of the connection.

Where structural or miscellaneous steel connections are welded, all butt and miter welds shall be continuous and, where exposed to view, shall be ground smooth. Intermittent welds shall have an effective length of at least 2 inches and shall be spaced not more than 6 inches apart.

Surfaces to be welded and surfaces within 2 inches of a weld shall be free from loose or thick scale, slag, rust, moisture, grease, paint and other foreign materials that would prevent proper welding or release objectionable fumes.

Only shielded metal arc, gas metal arc, flux cored arc, submerged arc, and gas tungsten arc welding are permitted. For flux cored arc welding, only E70xx one (1) or five (5) wire electrodes with supplemental gas shielding shall be permitted. Use of electroslag or electrogas welding processes or the short-circuiting transfer mode of the gas metal arc process will not be acceptable.

Field welded connections shall not be substituted for field bolted connections indicated on the Drawings.

3-4. STRUCTURAL AND MISCELLANEOUS ALUMINUM. Unless otherwise noted, all work shall conform to applicable provisions of the Aluminum Association "Specification for Aluminum Structures".

3-4.01. Connections. Connections not specifically detailed on the Drawings shall develop the full strength of the least strength member of the connections. Bolted connections shall be all-bolted bearing type, equipped with a helical spring lock washer under the stationary element (bolt head or nut) and a flat washer under the turned element. All bolts shall be fully tightened. Bolts and nuts for structural aluminum connections shall be stainless steel. A sufficient number of

bolts shall be provided in each connection to develop the shear strength of the member.

Welded connections shall be made in accordance with the American Welding Society D1.2, Structural Welding Code - Aluminum. All welding shall be performed by welders qualified in accordance with American Welding Society. Welds shall be free of porosity, cracks, holes, and flux. Welded connections shall not be substituted for bolted connections without prior approval of the Structural Engineer of Record.

3-4.02. Erection. Structural aluminum shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevation of horizontal members shall be within 1/16 inch of the elevation indicated on the Drawings.

End of Section

Section 05 52 13

METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel railings.
2. Aluminum railings.
3. Stainless-steel railings.

B. Related Requirements:

1. Structural Metals section for railings associated with stairs.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Steel Pipe and Tube Railings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. VIVA Railings, LLC.

    b. Approved equal.

B. Aluminum Pipe and Tube Railings:

1. Superior Aluminum Products, Inc.

2. Approved equal.

C. Stainless-Steel Pipe and Tube Railings:

1. VIVA Railings, LLC.

2. Approved equal.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, registered in the State of the project, to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated. An allowable stress increase of 1/3 shall not be incorporated into the design of any part of the railing system.

1. Handrails and Top Rails of Guards:

    a. Uniform load of 50 lbf/ ft applied in any direction.
    b. Concentrated load of 200 lbf applied in any direction.
    c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

    a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
    b. Infill load and other loads need not be assumed to act concurrently.

2.3 METALS, GENERAL

A. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.4 STEEL AND IRON

A. Tubing: ASTM A500 (cold formed).

B. Pipe: ASTM A53, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A36.

D. Cast Iron: Either gray iron, ASTM A48, or malleable iron, ASTM A47, unless otherwise indicated.

2.5 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Tubing: ASTM B221, Alloy 6063-T5/T52.

C. Extruded Structural Pipe and Round Tubing: ASTM B429, Alloy 6063-T6.

D. Drawn Seamless Tubing: ASTM B210, Alloy 6063-T832.

E. Plate and Sheet: ASTM B209, Alloy 6061-T6.

F. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.

G. Castings: ASTM B26, Alloy A356.0-T6.

2.6 STAINLESS STEEL

A. Tubing: ASTM A554, Grade MT 316L.

B. Pipe: ASTM A312, Grade TP 316L

C. Castings: ASTM A743, Grade CF 8M or CF 3M.

D. Plate and Sheet: ASTM A240 or ASTM A666, Type 316L.

2.7 FASTENERS

A. General: Provide the following:

1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5 for zinc coating.
2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A153 or ASTM F2329 for zinc coating.
3. Aluminum Railings: Type 316 stainless-steel fasteners.
4. Stainless-Steel Railings: Type 316 stainless-steel fasteners.

B. Post-Installed Anchors: Expansion anchors or adhesive anchors, as specified in the Anchorage in Concrete and Masonry section.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 or 2 stainless-steel bolts, ASTM F 93, and nuts, ASTM F594.

2.8 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Shop Primers: Provide primers that comply with the Protective Coatings section.

E. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

F. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

G. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.

H. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

I. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 187.

J. Non-shrink, Nonmetallic Grout: As specified in the Grouting section.

2.9 FABRICATION

A. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form work true to line and level with accurate angles and surfaces.

C. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

D. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

E. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

F. Form changes in direction by inserting prefabricated elbow fittings.

G. Close exposed ends of railing members with prefabricated end fittings.

H. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer

loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

2.10 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize steel railings, including hardware, after fabrication.
2. Comply with ASTM A123 for hot-dip galvanized railings.
3. Comply with ASTM A153 for hot-dip galvanized hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

C. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Do not apply primer to galvanized surfaces.

D. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: As selected by Architect from manufacturer's full range.

2.11 ALUMINUM FINISHES

A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Mill Finish: AA-M12, nonspecular as fabricated.

C. Clear Anodic Finish: AAMA 611, AA-M12C22A41.

2.12 STAINLESS-STEEL FINISHES

A. Stainless Steel Tubing Finishes:

1. 180-Grit Polished Finish: Uniform, directionally textured finish.
2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
3. Polished and Buffed Finish: 320-grit finish followed by buffing to a high luster finish.

B. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A489, No. 4.
2. High Luster Finish: ASTM A480, No. 7.
3. Mirror Finish: ASTM A480, No. 8.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

3.2 ANCHORING POSTS

A. Sleeve type: Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Post-Installed anchors: Fasten post base flanges to concrete in accordance with the Drawings and the Anchorage in Concrete and Masonry section.

C. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members.

3.3 ATTACHING RAILINGS

A. Attach railings to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads (4’-0” maximum).

B. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780.

End of Section

Section 05 53 13

METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, apply to this Section.

1.2 SUMMARY

A. Section includes metal bar gratings.

B. Related Requirements:

1. Structural Metals section for structural metal framing system components and metal framed stairs.
2. Metal Railings section for metal pipe and tube handrails and railings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Clips and anchorage devices for gratings.
2. Paint products.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fisher & Ludlow; a NUCOR Company.
2. Harsco Industrial IKG, a division of Harsco Corporation.
3. Ohio Gratings, Inc.
4. Approved equal.

2.2 METAL BAR GRATINGS

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, or "Heavy-Duty Metal Bar Grating Manual " where heavy-duty metal bar grating is required on the Drawings.

B. Welded Steel Grating:

1. Bearing Bar Spacing: 1-3/16 inches o.c.
2. Bearing Bar Depth: As indicated on Drawings.
3. Bearing Bar Thickness: 3/16 inch minimum.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Plain, unless indicated otherwise on the Drawings.
6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

C. Pressure-Locked, Stainless-Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.

1. Bearing Bar Spacing: 1-3/16 inches o.c.
2. Bearing Bar Depth: As indicated on Drawings.
3. Bearing Bar Thickness: 3/16 inch minimum.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Plain, unless indicated otherwise on Drawings.
6. Finish: Mill finish.

D. Pressure-Locked, Rectangular-Bar Aluminum Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.

1. Bearing Bar Spacing: 1-3/16 inches o.c.
2. Bearing Bar Depth: As indicated on Drawings.
3. Bearing Bar Thickness: 3/16 inch minimum.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Plain, unless indicated otherwise on Drawings.
6. Aluminum Finish: Mill finish.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A36.

B. Steel Bars for Bar Gratings: ASTM A36 or steel strip, ASTM A1011 or ASTM A1018.

C. Wire Rod for Bar Grating Crossbars: ASTM A510.

D. Uncoated Steel Sheet: ASTM A1011, structural steel, Grade 30.

E. Galvanized-Steel Sheet: ASTM A653, structural quality, Grade 33, with G90 coating.

F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240, Type 316L.

G. Stainless-Steel Bars and Shapes: ASTM A276, Type 316L.

2.4 ALUMINUM

A. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.

B. Extruded Bars and Shapes: ASTM B221, alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.

C. Aluminum Sheet: ASTM B209, Alloy 5052-H32.

2.5 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563 and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group 2.

2.6 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with the Protective Coatings section.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.7 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
2. Fabricate toeplates for attaching in the field.
3. Toeplate Height: 4 inches unless otherwise indicated.

G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
2. Provide no fewer than four saddle clips for each grating section containing rectangular bearing bars 3/16 inch or less in thickness

and spaced 15/16 inch or more o.c., with each clip designed and fabricated to fit over two bearing bars.

3. Provide no fewer than four weld lugs for each grating section containing rectangular bearing bars 3/16 inch or less in thickness and spaced less than 15/16 inch o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
4. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
5. Furnish threaded bolts with nuts and washers for securing grating to supports.
6. Furnish self-drilling fasteners with washers for securing grating to supports.
7. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Kee Safety, Ltd.
        2) Lindapter International.
        3) Approved equal.

H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

I. Do not notch bearing bars at supports to maintain elevation.

2.8 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153 for steel and iron hardware and with ASTM A123 for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Shop prime gratings not indicated to be galvanized unless otherwise indicated.

1. Shop prime with universal shop primer.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in the Protective Coatings section.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

End of Section

Section 05 81 00

ANCHORAGE IN CONCRETE AND MASONRY

PART 1 - GENERAL

1-1. SCOPE. This section covers the design and installation of anchors in concrete and masonry. It includes cast-in-place anchor bolts and anchor rods, adhesive anchors for both threaded rods and reinforcing bars, expansion anchors, and undercut anchors.

1-2. GENERAL.

1-2.01. Anchors Designed by Design Builder. Cast-in-place and post-installed anchors that are fully detailed on the Drawings have been designed by Design Builder.

1-2.02. Anchors Designed by Design Builder's Suppliers. Design Builder's material suppliers shall be responsible for design of anchors for railings, ladders, equipment, pre-engineered structures, and other manufactured items, as indicated in the Drawings and Specifications. Anchors shall be designed for all operating conditions, including wind and seismic loadings when indicated in the Meteorological and Seismic Design Criteria section. Cast-in-place anchors shall be used unless post-installed types are indicated on the Drawings or accepted by Design Builder. Post-installed anchors used in vibrating applications, such as for pumps, shall only be used if the manufacturer submits documentation indicating that the product is suitable for the service conditions.

1-2.03. Materials. Unless otherwise indicated, anchors of structural steel members connected to concrete shall have a diameter of at least 3/4 inch, and structural members connected to masonry shall have a diameter of at least 5/8 inch. Anchors for ladders and equipment shall have a diameter of at least 1/2 inch. Anchors for pedestrian railing systems shall have a diameter of at least 3/8 inch.

Unless otherwise indicated on the Drawings, anchors used in the following locations and applications shall be of the indicated materials.

Cast-In-Place Anchor Bolts and Anchor Rods

Submerged locations	Stainless steel.
Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Galvanized steel.
Other exterior locations	Galvanized steel.
Other interior locations	Carbon steel.

Adhesive, Expansion, and Undercut Anchors

Submerged locations	Stainless steel.
Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Stainless steel.
Other exterior locations	Stainless steel.
Other interior locations	Carbon steel.

Adhesive, expansion, and undercut anchors may be used instead of cast-in-place anchors only where specifically indicated or permitted on the Drawings or with the specific acceptance by Design Builder.

1-3. SUBMITTALS. Data, catalog cuts, and manufacturer's research reports (from independent organizations such as ICC-ES or IAPMO UES) indicating the manufacturer and types of adhesive anchors, expansion anchors, and undercut anchors to be supplied shall be submitted in accordance with the Submittals Procedures section.

Calculations shall be prepared by a professional engineer licensed in the state of California, using methods and procedures required by the building code.

1-4. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent damage or corrosion. Damaged materials shall be promptly replaced. Materials shall be shipped and stored in original manufacturer's packaging.

PART 2 - PRODUCTS

2-1. MATERIALS. Unless otherwise indicated on the drawings, materials shall be as indicated below.

Cast-In-Place Anchor Bolts and Anchor Rods	
Carbon steel	ASTM F1554, Grade 36 with compatible nuts.
Galvanized steel	ASTM F1554, Grade 36 with compatible nuts; hot-dip galvanized, ASTM F2329.
Stainless steel	Bolts, ASTM F593, Alloy Group 1 or 2 (minimum yield strength of 45 ksi); nuts, ASTM F594, Alloy Group 1 or 2.
Flat Washers	ANSI B18.22.1; of the same material as anchor bolts and nuts.
Expansion Anchors in Concrete	Products shall be single component anchors tested in accordance with ICC AC193, and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces. Hilti "Kwik-Bolt TZ" or Powers Fasteners "Power-Stud+SD2" (carbon steel), "Power-Stud+SD4" (304 stainless steel), and "Power-Stud+SD6" (316 stainless steel).
Expansion Anchors in Grouted Concrete Masonry Units	Products shall be single component anchors tested in accordance with ICC AC01, and shall have a manufacturer's research report in compliance with the applicable building code. Hilti "Kwik-Bolt TZ Masonry Anchors", Simpson "Wedge-All", or Powers Fasteners "Power-Stud+ SD1".

Undercut Anchors in Concrete	Products shall be tested in accordance with ICC AC193, and shall have a manufacturer's research report in compliance with the applicable building code. Hilti "HDA Undercut Anchor" (carbon steel) and "HDA-R Undercut Anchor" (stainless steel), or Powers Fasteners "Atomic+ Undercut Anchor" (A36 carbon steel).
Adhesive Anchors in Concrete	Products shall be tested in accordance with ICC AC308, and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593, CW.
Reinforcing Bars	ASTM A615, Grade 60, deformed.
Reinforcing Bars, weldable	ASTM A706, Grade 60, deformed.
Adhesive	Hilti "HIT-RE 500 V3", or Simpson "SET-3G".
Adhesive Anchors in Grouted Concrete Masonry Units	Products shall be tested in accordance with ICC AC58, and shall have a manufacturer's research report in compliance with the applicable building code.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593 CW (Hilti or Powers systems), or ASTM A193 Grades B6, B8, or B8M (for Simpson system).
Adhesive	Hilti "HIT HY 270", Powers "AC100+ Gold", or Simpson "SET XP".

Adhesive Anchors in Hollow Concrete Masonry Units	Products shall be tested in accordance with ICC AC58, and shall have a manufacturer's research report in compliance with the applicable building code.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593 CW (Hilti or Powers systems), or ASTM A193 Grades B6, B8, or B8M (for Simpson system).
Adhesive	Hilti "HIT HY 270", Powers "AC100+ Gold", or Simpson "SET XP".
Screen Tubes	As recommended by the manufacturer.
Adhesive Anchors in Unreinforced Brick Masonry	Products shall be tested in accordance with ICC AC60, and shall have a manufacturer's research report in compliance with the applicable building code.
Threaded Rods and Nuts	ASTM A307.
Adhesive	Hilti "HIT HY 270", Simpson "SET".
Screen Tubes	As recommended by the manufacturer.

2-2. ANCHORS.

2-2.01. Cast-in-Place Anchor Bolts and Anchor Rods. Cast-in-place anchor bolts and anchor rods shall have forged heads or embedded nuts and washers. Anchors shall be delivered in time to permit setting prior to the placing of structural concrete or masonry grout. Anchor sleeves shall not be used unless acceptable to Design Builder. Unless installed in sleeves, anchor bolts and anchor rods shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or the supporting template. Two nuts, a jam nut, and a washer shall be furnished for cast-in-place anchor bolts and anchor rods indicated on the Drawings to have locknuts; two nuts and a washer shall be furnished for cast-in-place anchor bolts and anchor rods without locknuts.

2-2.02. Adhesive, Expansion, and Undercut Anchors. When adhesive, expansion, or undercut anchors are indicated on the Drawings, only acceptable systems shall be used. Acceptable systems shall include only those systems and products specified or specifically indicated by product name on the

Drawings. Alternative anchoring systems may be used only when specifically accepted by Design Builder.

Unless otherwise noted, single nuts and washers shall be provided with adhesive anchors, expansion anchors, and undercut anchors. Adhesive anchors shall be free of coatings that would weaken the bond with the adhesive.

Adhesive anchors in hollow CMU masonry and unreinforced brick masonry shall utilize screen tubes as recommended by the manufacturer.

PART 3 - EXECUTION

3-1. GENERAL. Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchors immediately before tightening of the nuts.

3-1.01. Compliance With Manufacturer's Instructions. Post-installed anchors shall be installed in accordance with the manufacturer's printed installation instructions and all applicable requirements of the manufacturer's research report for the specific anchor system. If conflicts are found between the Drawings, the manufacturer's printed installation instructions, and the manufacturer's research report installation requirements, Design-Builder shall notify Structural Engineer of Record for resolution

3-1.02. Special Inspection. Special inspection requirements for cast-in-place and post-installed anchors shall be as indicated in the Code-Required Special Inspections and Procedures section or as noted in Drawings. Anchorage work shall be performed in a manner that allows the inspections to take place without adversely impacting the schedule.

3-2. CAST-IN-PLACE ANCHOR BOLTS AND ANCHOR RODS. Cast-in-place anchor bolts and anchor rods shall be carefully positioned with templates and secured in the forms prior to placing concrete, or in masonry bond beams prior to placing grout. Design-Builder shall verify that anchorage devices are positioned in accordance with the Drawings and with applicable equipment or structure submittal drawings.

Threads, bolts, and nuts spattered with concrete or masonry grout during placement shall be cleaned prior to final installation of the bolts and nuts.

Sleeves shall be filled with non-shrink grout.

3-3. ADHESIVE ANCHORS. Adhesive shall be statically mixed in the field during application. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.

Anchors or bars shall be installed in holes hammer drilled into hardened concrete or masonry. Drill shall be set to rotation-only mode when drilling into hollow CMU or into brick. Diameter of holes shall be 1/16 inch larger than the outside diameter of the rod or bar unless recommended otherwise by the anchor system manufacturer. Holes shall be prepared by removing all dust and debris using procedures recommended by the adhesive manufacturer.

Adhesive anchors and holes shall be clean, dry, and free of grease and other foreign matter at the time of installation. The adhesive shall be placed and the rods or bars shall be set in accordance with the recommendations of the manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with adhesive, without voids.
Do not drill through existing reinforcing. A small diameter test hole shall be drilled at the installation location. If existing reinforcing is encountered, the installation location shall be relocated to avoid conflict and the abandoned hole shall be filled with non-shrink grout or drypack. Other non-destructive means may be used to identify the positions and depth of reinforcing.

3-3.01. Concrete Installation. Unless indicated otherwise on the Drawings, reinforcing bars shall be embedded to a depth of 15 bar diameters, and threaded rods shall be embedded to a depth that will develop the yield strength of the rod.

Adhesive anchors in concrete shall be installed under the following conditions.

Minimum Age of Concrete Prior to Anchor Installation	21 days.
Concrete Temperature Range	Maximum short-term temperature 162 F, maximum long-term temperature 110 F.
Moisture Condition	Dry concrete.
Type of Lightweight Concrete	N/A
Hole Drilling and Preparation	Hammer drill only.

Installation of adhesive anchors into concrete that are either horizontal or upwardly inclined shall be performed only by personnel certified by the ACI/CRSI Adhesive Anchor Installation Certification Program.

3-3.02. Masonry Installation. Anchors shall be installed to meet all criteria in the manufacturer's installation instructions and ICC-ES reports, including but not limited to minimum compressive strength at time of installation, minimum edge distances, minimum clearances from mortar joints, minimum anchor spacing, and use of screen tubes.

3-4. EXPANSION AND UNDERCUT ANCHORS. Expansion and undercut anchors shall be installed using all procedures and accessory devices recommended by the anchor manufacturer.

End of Section

Section 06 41 00

CASEWORK

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Custom fabricated cabinet units.

B. Countertops and laboratory tops.

C. Cabinet hardware.

1.02 RELATED WORK

A. Section 05 40 00 - Cold Formed Metal Framing.

B. Section 09 25 00 - Gypsum Board.

C. Section 09 90 00 - Paints and Coating.

D. Division 22 - Plumbing.

E. Division 26 - Electrical.

1.03 REFERENCES

A. FS MM-L-736 - Lumber, Hardwood.

B. FS MMM-A-130 - Adhesive, Contact.

C. PS 1 - Construction and Industrial Plywood.

D. PS 20 - American Softwood Lumber Standard.

E. PS 51 - Hardwood and Decorative Plywood.

F. PS 58 - Basic Hardboard.

G. NEMA LD3 - High Pressure Decorative Laminates, Solid Plastic Sheet.

H. ASTM D638-08 - Tensile Properties of Solid Plastic Sheet.

I. ISSDA-2 - Classification and Standard, Solid Surfacing Material.

J. Woodwork Institute - Architectural Woodwork Standards, current edition.

1.04 QUALITY ASSURANCE

A. Manufacture all casework in accordance with the standards in the latest edition of the "Architectural Woodwork Standards" of the Woodwork Institute, in “Custom” grade or better.

B. A Woodwork Institute Compliance Certificate is not required. However, any casework which falls below the specified Woodwork Institute grade requirements shall be replaced or modified to satisfaction of, and at no additional cost to, the Owner.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00.

B. Shop drawings shall indicate Woodwork Institute construction references. Include materials, component profiles, fastening methods, assembly methods, joint details, finishes, accessories and hardware locations, to a minimum scale of 3/8 inch to 1 foot.

C. Submit samples under provisions of Section 01 33 00.

D. Submit minimum 2" x 2" samples of available colors and patterns for plastic laminate and plastic solid surface materials.

PART 2 - PRODUCTS

2.01 GRADES

A. Provide wood casework in accordance with AWI / WI / AWMAC "Manual of Millwork", Section 15: Casework - Laminated Plastic, latest edition, for Custom Grade, except as otherwise specified below.

1. Construction Style: Style A frameless, unless shown otherwise.

2. Construction Type: Type II, single length sections to fit access openings.

B. Seismic Force Construction: Construct all products using construction methods tested to meet the seismic resistance requirements of the California Building Code (Title 24 CCR, Part 2), as described by the Woodwork Institute.

2.02 LUMBER MATERIALS

A. Interior Softwood Lumber: PS 20; Custom grade in accordance with AWI; maximum moisture content of 8 percent; fir or pine species, with mixed

grain, paint grade unless specifically required to be stain grade. Finger jointed material is allowed in paint grade applications.

B. Exterior Softwood Lumber: Custom grade per AWI; maximum moisture content of 19%; Douglas fir or hemlock species, with mixed grain, paint grade unless specifically required to be stain grade.

C. Hardwood Lumber: FS MM-L-736; Custom grade in accordance with AWI; maximum moisture content of 8 percent; beech or similar species as approved by Architect, stain grade.

2.03 CASEWORK MATERIALS

A. High Pressure Laminate: Nominal 0.05 inch general purpose grade decorative laminate by Formica or Wilsonart as scheduled on the Drawings, suede finish unless otherwise noted, meeting reference standard NEMA LD3.

B. Low Pressure Laminate: Melamine or polyester resin impregnated paper decorative laminate meeting reference standard NEMA LD3; solid color Melamine for shelf surfaces.

C. Window Stools, Solid Surface: 3/4" solid homogenous filled resin meeting reference standard ISSDA-2, Corian or equivalent, color and pattern as selected by Architect.

D. Exposed Cabinet Frames, Exposed and Semi-exposed Door and Drawer Faces, Shelves:Custom grade fiberboard, hardwood or plywood to accept vertical application of solid color high-pressure plastic laminate.

E. Door and Drawer Front Style: Flush overlay. All door and drawer fronts to be Woodwork Institute Type A, unless otherwise directed.

F. Exposed Door and Drawer Edges at Laminate Surfaced Cabinets and Shelves: PVC unglued edgebanding material in color to match adjacent plastic laminate finishes, as manufactured by Frama-Tech Inc. or equivalent. Polyester paper tape is not acceptable for edgebanding.

G. Plastic Laminated Countertops and Backsplashes:

1. Custom grade fiberboard, hardwood or plywood to accept patterned high-pressure plastic laminate.

H. Laboratory Countertops:

1. Product: Durcon Classic or approved equivalent fabricated solid epoxy resin, 1 inch thick unless otherwise noted.

2. Edge Treatment: 1/8 inch chamfered edge.

I. Wood Casework:

1. Exposed Cabinet Frames, Exposed and Semi-exposed Door and Drawer Faces, Shelves: Custom, hardwood or plywood to accept vertical application of solid color high-pressure plastic laminate.

2. Exposed Door and Drawer Edges: Solid hardwood, except manufactured hollow core doors at wardrobes.

3. Wood species: Stain grade beech.

2.04 HARDWARE

A. Finish Hardware: Provide finish hardware for all casework included in the work of this Section. All hardware shall be installed by the casework fabricator. Alternate products to those listed below will be approved if equivalent on the basis of submittals made under provisions of Section 01 33 00.

B. Drawer Slides: KV Series 8417 or equivalent, full extension, self-closing 75 lb. rated.

C. Adjustable Shelving Supports: KV Model 346 ANO chrome anodized metal supports for drilled holes, 1/4-in. diameter pin, approximately 3/8-in. insertion in pre-drilled holes, 1/2-in shelf support with anchoring screw hole. Supply supports complete with #6 x 1/2-in. wood screw anchors.

D. Cabinet Pulls: Mockett or equivalent metal recessed pull, color as selected by Architect.

E. Cabinet Hinges: Blum "Clip" Concealed Hinges for 125^{o} opening, overlay style, self-closing, Model 75M or equivalent as appropriate for the application.

F. Other Finish Hardware: Provide all cabinet hardware as shown in the Drawings and as necessary for a complete and functional installation, whether or not specifically shown. Unless otherwise specified, hardware finish shall be brushed chrome or brushed stainless steel.

2.05 ACCESSORIES

A. Contact Adhesives for Plastic Sheet and Laminate: As recommended or approved by the product manufacturer.

B. Fasteners: Size and type to suit application.

C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; finish to minimize contrast with adjacent finished surface in exposed locations.

D. Lumber for shimming, blocking and bracing: Softwood lumber of Douglas Fir, coastal species.

E. Wood Filler: Solvent base, tinted to match surface finish color.

2.06 FABRICATION

A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.

B. Fit shelves and miscellaneous exposed edges with edging to eliminate exposed core material. Use full length pieces only.

C. Design is based on full 3/4 inch thick door and drawer fronts.

D. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting as approved by the Architect on the basis of shop drawings and samples.

E. Make countertop corners and joints invisible. Slightly bevel arrises.

F. Provide firm support for solid surface materials with spaced or solid wood as recommended by solid surface manufacturer or referenced Woodwork Institute standards.

G. Provide cutouts for plumbing and electrical fixtures, inserts, appliances, outlet boxes, and other fixtures and fittings. Seal contact surfaces of cut edges.

H. Assemble cases using approved Woodwork Institute jointing methods tested to meet the seismic force requirements of the California Code of Regulations Title 24, as referenced in Section 15 of the Woodwork Institute Manual of Millwork.

I. Cooperate and coordinate with the plumbing contractor in the installation of plumbing components within or attached to casework, including items of rough plumbing concealed within casework and sinks.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify adequacy of backing and support framing.

B. Bring any deficiencies to the attention of the Design-Builder for resolution prior to proceeding with casework installation.

3.02 INSTALLATION

A. Set and secure casework in place rigid, plumb, and level, in accordance with Woodwork Institute “Custom” or higher quality standards.

B. Use concealed attachments for wall mounted components.

C. Use Woodwork Institute recommended concealed joint fasteners to align and secure adjoining cabinet units and counter tops

D. Carefully scribe casework which is against other building materials, leaving gaps of 1/32 inch maximum. Do not use additional overlay trim for this purpose.

E. Secure cabinet and counter bases to floor using approved anchorages shown and detailed in approved shop drawings.

F. Use scribe moldings and closure trims only as approved in advance by the Architect.

G. Apply sealant per Section 07 92 00 at casework and countertop joints subject to moisture and at joints between casework and other materials, wiping joints to achieve a minimal exposed line of sealant.

H. Apply waterproof sealant to toe kick/floor joint after finish floor has been laid. Wet set base shoe to create seal.

I. Install all pulls.

3.03 ADJUSTING AND CLEANING

A. Adjust doors, drawers, shelves, hardware, fixtures and other moving or operating parts to function smoothly and correctly. Doors and drawers shall either remain in a neutral position when opened or self close.

B. Clean casework, counters, shelves, hardware, fittings and fixtures.

C. Clean adhesive and excess sealant from adjacent surfaces.

End of Section

Section 06 74 15

FIBERGLASS REINFORCED RAILINGS

PART 1 - GENERAL

1-1. SCOPE. This section covers the design, fabrication and installation of hand railing and guard railing fabricated from fiberglass shapes. Metal railing systems, concrete and masonry anchorage, and structural metals are covered in other sections.

1-2. GENERAL. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1-3. SUBMITTALS. Complete data, detailed drawings, and setting or erection drawings covering all materials shall be submitted in accordance with the Submittals Procedures section. Each separate piece shall be marked.

Railing drawings shall be sealed by a professional engineer registered in the state of the project.

Data shall be submitted to certify that railings meet all applicable requirements of the codes as specified herein and the Specifications and Drawings. The Structural Engineer of Record may request copies of all supporting calculations.

1-3.01. Samples. Samples shall be submitted to indicate finishes. Samples of each type of fitting required to complete the installation shall also be submitted.

1-3.02. Colors. Where color selections are required, color charts shall be submitted showing the full range of available colors. Procedures for selecting colors shall be as indicated in the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. GENERAL. Railing systems shall be designed and fabricated by companies normally engaged in the manufacture of such systems. Railing products shall be from a single supplier and the installed systems shall have a uniform appearance throughout the project.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS.

2-2.01. Railing System Design Criteria. All railing systems shall be designed and fabricated in compliance with the most stringent requirements of the applicable local building code, OSHA 29 CFR Part 1926 Subpart R, and all other pertinent OSHA regulations and local safety regulations. In case of conflicting requirements the more stringent requirements shall be applicable.

At a minimum, guard railing and handrailing shall be designed to withstand a uniform load of 50 lb/ft applied in any direction at the top, and a concentrated load of 200 lb applied in any direction at any point along the top. The uniform load and the concentrated load need not be assumed to act concurrently. The design load shall be transferred through the entire railing system and its attachment to the structure.

Intermediate rails, including balusters on picket-type systems, shall be designed to withstand a horizontally applied normal load of 50 lb on an area not to exceed 12 inches by 12 inches including openings and space between rails. The load shall be located so as to produce the maximum effects. Reactions due to this loading are not required to be superimposed with the loads specified for the top rail and handrail.

An allowable stress increase of 1/3 shall not be incorporated into the design of any part of the railing system.

Maximum spacing for railing posts shall be 4 ft.

2-2.02. Rails. Handrails shall be fabricated from 1-1/2 inch minimum fiberglass reinforced pultruded square tube. Guardrails shall be fabricated from 1-3/4 inch minimum fiberglass reinforced pultruded square tube. Pickets shall be fabricated from 3/4 inch fiberglass reinforced round tube.

2-2.03. Kickplate. Kickplates shall be four inches high and shall be fabricated from similar materials as the railing. Kickplates shall clear the walking surface by 1/4 inch.

2-2.04. Fasteners. Unless noted otherwise, all fasteners shall be stainless steel. Where galvanized bolts are indicated on the Drawings or specified, the use of zinc-plated bolts will not be acceptable. Railings shall be connected with epoxy bonded connections in accordance with the manufacturer's standard details. Fastener details shall be indicated on the submittal drawings.

2-2.05. Guarding of Openings. Openings in railing shall be guarded by self-closing gates in accordance with OSHA 1910.23.

2-2.06. Removable Guardrail. Removable guardrail sections shall be designed so that each section has at least two, but not more than three posts.

2-2.07. Expansion Control. Guardrailing in outdoor locations shall have slip joints at least every 60 ft and at all concrete expansion joints to permit expansion and contraction. The gap at each slip joint shall be not less than 1/4 inch.

2-2.08. Mounting to Structure. Railing systems shall be mounted to structures as indicated on the Drawings. If mounting details are not indicated, railing posts shall be surface mounted with base flanges or side mount brackets secured to concrete by stainless steel adhesive anchors. Bolt sizes and pattern shall be as needed for the mounting device.

2-3. ACCEPTABLE MANUFACTURERS. Fiberglass rail shall be Fibergrate Composite Structures “Dynarail”, Strongwell “Safrail”, without exception.

2-4. MATERIALS.

Fiberglass Systems	
Tube	Fiberglass reinforced pultruded square tube with surfacing veil and UV inhibitors in vinyl ester resin, ASTM E84 flame spread of 25 or less.
Kickplate	Fiberglass reinforced pultruded corrugated plate with surfacing veil and UV inhibitors in vinyl ester resin, ASTM E84 flame spread of 25 or less.
Hardware	Manufacturer’s standard, AISI Type 316 stainless steel.
UV Protective Coating	Manufacturer’s standard, polyurethane.
Steel Pipe Sleeves	
Outer Sleeves	Black steel pipe, Schedule 40. Hot-dip galvanized after fabrication.
Removable Post Inner Sleeves	PVC tube, Schedule 40.
Plastic Pipe Sleeves	PVC tube, Schedule 40.
Post Setting Cement	Minwax "Super Por-Rok Cement" or BASF Set Products Division "Set 45".
Anchorage to Prime Painted Steel	High strength bolts, nuts, and washers in accordance with the Structural Metals section.

Anchorage to Concrete or Masonry	Stainless steel adhesive anchors in accordance with the Anchorage in Concrete and Masonry section.

2-5. FABRICATION. Unless otherwise indicated on the Drawings, all railings provided under this section shall be of the same type and design.

2-5.01. Fiberglass Railings. Fiberglass handrails and guardrails shall be fabricated into finished sections of the configurations indicated on the Drawings by fabricating and joining fiberglass tube shapes using molded connectors and pultruded components epoxy bonded and connected as recommended by the railing manufacturer. Where kickplates are indicated, the kickplates shall be attached to the railing posts with stainless steel or nylon fasteners. Top rails shall run continuously over posts. All rails and posts shall be in the same plane and shall not be offset.

2-5.02. Guarding of Openings. Openings in railing shall be guarded by self-closing gates. Self-closing gates shall be fabricated of the same materials with the same finish as the guard railing. The closure device shall be Manufacturer's standard.

2-5.03. Sleeves. Sleeves for fixed handrail posts shall be fabricated from Schedule 40 PVC pipe or from Schedule 40 black steel pipe hot-dip galvanized after fabrication. Sleeves shall provide at least 1/4 inch clearance all around each post and shall be 5 inches long unless otherwise indicated on the Drawings.

Sleeves for removable posts shall have an outer and inner sleeve. The outer sleeve shall be fabricated from Schedule 40 black steel pipe and shall be hot-dip galvanized after fabrication. The inner sleeve shall be Schedule 40 PVC pipe.

2-6. COATING. Fiberglass materials in outdoor locations shall be coated for UV protection. Railing color shall be yellow.

PART 3 - EXECUTION

3-1. INSTALLATION. When railings are assembled, all posts shall be plumb and longitudinal members shall be parallel with each other and with the floor surface or slope of stairs. In any section or run of railing, the center lines of all members shall be in true alignment, positioned in the same vertical plane. All posts in fixed handrail sections shall be rigidly attached to the supporting structure. After installation, railings shall be checked for final alignment, using a tightly drawn wire for reference. The maximum misalignment tolerance for railings shall be 1/8 inch in 12 ft. Bent, deformed, or otherwise damaged installations shall be replaced.

Cut or drilled fiberglass pieces shall be sealed with catalyzed resin in accordance with the fiberglass manufacture's recommendations.

3-1.01. Attachment to Concrete. Posts shall be attached to concrete structures as indicated on the Drawings. Base flanges and side-mount brackets shall be installed with minimal disturbance to the reinforcing steel. Bolts shall be stainless steel adhesive anchors as specified in the Anchorage in Concrete and Masonry section.

Sleeves shall be rigidly supported in accurate alignment in the forms and shall be positioned vertically so that the top of each sleeve is approximately 1/2 inch below the finished concrete surface. The position of all sleeves shall be carefully measured before railings are fabricated. When the railing is set, the posts shall be wedged in accurate alignment, and the annular space between the posts and sleeves shall be filled with post setting cement to the top of the steel sleeve. Filling of the remaining space with sealant, as indicated on the Drawings, is covered in the Caulking section.

3-1.02. Removable Attachments. For removable guardrail sections in embedded sleeves, inner sleeves shall be set in outer sleeves in the same manner as specified herein for the setting of fixed posts. Particular care shall be taken to ensure that the inner sleeves are accurately spaced and plumbed, so that the guardrail sections, when set in position, will stand in proper alignment and will be removable without binding.

Removable guardrail sections with base flanges or side mount brackets shall be secured in the bases with removable screws.

3-1.03. Wall Mounted Handrailing. Suitable wall brackets shall be provided where shown or required. Wall brackets shall be securely anchored to walls with stainless steel adhesive anchors as specified in the Anchorage in Concrete and Masonry section. Expansion anchors shall not be used unless specifically indicated on the Drawings.

End of Section

Section 07 05 00

MEMBRANE ROOFING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Single ply PVC membrane roofing.

B. Roof boards.

C. Shaped rigid insulation.

D. All accessories, labor and materials necessary for a complete and weathertight installation of the work of this Section, whether or not specifically described.

1.02 RELATED WORK

A. Section 05 40 00 - Cold-Formed Metal Framing.

B. Section 07 20 00 - Building Insulation.

C. Section 07 60 00 - Flashing and Sheet Metal.

D. Section 07 92 00 - Joint Sealers.

E. Division 22 – Plumbing.

1.03 SUBMITTALS

A. Submit product data and materials list under provisions of Section 01 33 00. Include manufacturer's installation instructions.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM): Reference latest revisions of standards unless otherwise indicated.
   1. ASTM D 4434-87: Standard Specification for Polyvinyl Chloride Sheet Roofing
   2. ASTM C 272-91: Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
   3. ASTM C 1289-95: Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board:
   4. ASTM D 162173: Test Method for Compressive Properties of Rigid Cellular Plastics.
   5. ASTM C 578-91a - Federal Specification No. H-H-I-524B. Types I & II EPS Insulation.
   6. ASTM E 108: Standard Method for Fire Testing of Roof Coverings.

B. Underwriters Laboratories:
   1. ANSI/UL Standard 790: Test for Fire Resistance of Roof Covering Materials.

C. Factory Mutual:
   1. Factory Mutual System Approval Standard: Class I Roof Covers, Class Number 4470.

D. SMACNA Architectural Sheet Metal Manual, current edition.

1.05 ROOF SYSTEM DESCRIPTION

A. Installation of roof system, insulation and roof deck shall conform to contract document requirements. Industry practices apply only when specification and/or project documents do not address an item. Manufacturer's specification designed specifically for this project may supersede printed literature.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Current California C-39 Roofing Contractor license.
   2. Written proof of manufacturers approved applicators status for this project.

B. Submit the following manufacturer qualifications:
   1. Sample of manufacturers warranty and/or addendum’s to be issued for this project in conjunction with specification warranty.

B. Regulatory Requirements:
   1. Underwriters Laboratories (UL): Fire Classification Rating: UL 790 Standard "Class A."
   2. Factory Mutual: Factory Mutual approved fastening.
   3. Meet applicable provisions of local, state and national building codes.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver roofing materials and accessories in manufacturer's original protective containers with labels intact and legible. Comply with manufacturer's published instructions for storage and handling.

B. Store materials in dry protected areas, on clean, raised platforms with securely anchored weather protective covering.

1.08 PROJECT CONDITIONS OR SITE CONDITIONS

A. Proceed with roofing work only when weather conditions comply with manufacturer's recommendations. Do not exceed temperature limitations recommended by the manufacturers.

1.09 WARRANTY

A. Manufacturer Warranty:
   1. Provide a NDL twenty (20) year warranty covering materials and workmanship as to include leaks and defective materials. The effective date of the warranty shall be the "date of completion" as determined in accordance with contract documents.

B. Contractors Warranty:
   1. The Contractor shall guarantee the Work for a period of three (3) years from the date of Substantial Completion. If during any period of any guarantee, warranty or the like, any of the Work is found to be in need of repair or replacement, the Contractor shall, at no expense to the Owner, repair or replace any such Work after receipt of notice from the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Manufacturer must currently meet established criteria of this section and related contract documents. Acceptable manufacturers:
      a. Sika Sarnafil
      b. Johns Manville

B. Alternate products may be used on the basis of submittals made under provisions of Section 01 33 00.

2.02 FASTENERS

A. Fasteners for Sheet Metal:
   1. Stainless Steel Sheet Metal Screw: One quarter (1/4) inch Phillips head, twin lead fifteen and one half (15-1/2) threads per inch of sufficient length to penetrate the metal a minimum of one-half (1/2) inch, with neoprene washer.
   2. Solder: ASTM B32; 50/50 type.

2.03 ADHERENTS/ADHESIVE/SEALANTS

A. Bolt Sealant:
   1. Clear Silicone, gunable to minus twenty (-20°) degrees. Mildew and fungus resistant, alkaline and acid stable, paintable, minimum of eight hundred (800) percent elongation, conforming to ASTM-C-920.

B. General Caulking Sealant:
   1. Product: Elastomeric Sealant.
   2. Description: Single component, gun grade, non-sag, elastomeric polyurethane sealant.

3. Usage: All details requiring caulking/sealant.

C. Seam Sealant:
   1. Product: Sarnacol 2170 / 2172.
   2. Description: Liquid Thermoplastic compound.
   3. Usage: Placed at the edge of PVC membrane seams.

D. Water Cutoff Sealant:
   1. Description: One component low viscosity, self-wetting butyl blend mastic.
   2. Usage: Sealing agent for temporary watertight seals.

2.04 ROOFING MEMBRANE

A. Surface Membrane/Flashing Membrane:
   1. Product: Sika Sarnafil G 410-20 EL.
      a. Description: Fused thermoplastic fiber reinforced PVC.
      b. Thickness: 60 mil (1.5 mm).
      c. Usage: Surface membrane.
      d. Color: Reflective Gray.

2.05 FLASHING

A. Unreinforced Flashing Membrane:
   1. Product: Sika Sarnafil G 410-18EL.
      a. Description: Fused thermoplastic fiber reinforced PVC.
      b. Thickness: 18 mm.
      c. Usage: Flashing membrane.
      c. Color: Reflective Gray.

B. Foil Tape:
   1. Product: (any)
      a. Description: Dead soft aluminum foil tape with acrylic adhesive backing
      b. Usage: As indicated in project drawings.
      c. Thickness: 3 mil.

C. Prefabricated Penetration Boots:
   1. Product: Sika Sarnafil accessory products.
      a. Description: Fused thermoplastic fiber reinforced /nonreinforced PVC.
      b. Usage: Flashing.
      c. Color: Reflective Gray.
      d. Dimensions: ASTM D-751-79.

2.06 ROOF BOARDS

A. Acceptable Manufacturers:
   1. DensDeck Roof Boards by Georgia-Pacific Gypsum, LLC.
   2. Alternate products may be used on the basis of submittals made under provisions of Section 01 33 00.

B. Fiberglass Matt Faced Gypsum Roof Boards:
   1. Acceptable Product: GP Gypsum, DensDeck® Prime Roof Boards.
   2. Thickness: 5/8 inch.
   3. Surfacing: Primed Fiberglass Mat.
   4. Flexural Strength, Parallel (ASTM C473): 40 lbf, minimum.
   5. Permeance (ASTM E96): Greater than 30 perms.
   6. Water Absorption (ASTM C473): Less than 5 percent of weight.
   7. Flame Spread/ Smoke Development (ASTM E84): Not more than 0 Flame Spread, 0 Smoke Development .
   8. Combustibility (ASTM E136): Noncombustible.
   9. Fire resistance rating (UL 790 and ASTM E108): Class A.
   10. Mold Resistance (ASTM D3273): Scored 10.

C. Additional Materials:
   1. FM or UL approved flat bottom plates and fasteners: Provide size and type in accordance with FM or UL requirements and roof membrane manufacturer's written recommendations.
   2. Adhesives: As recommended by roof system manufacturer or as required by tested assembly.

2.07 RIGID INSULATION

A. Acceptable Manufacturers:
   1. Foamular Tapered Rigid Foam Insulation by Owens Corning.
   2. Alternate products may be used on the basis of submittals made under provisions of Section 01 33 00.

B. Extruded Polystyrene (XPS) Rigid Foam Roof Insulation:
   1. Acceptable Product: Thermapink 25 XPS Tapered Insulation.
   2. Product Standard:ASTM C578 Type IV.
   3. Thickness: As required per Drawings.
   4. Material: Extruded polystyrene.
   5. Minimum Slope: 1/4 inch per foot.
   6. Compressive Strength (ASTM D1621): 25 PSI minimum.
   7. Water Absorption (ASTM C272): Less than 10% by volume.
   8. Flame Spread: Comply with ASTM E84.

C. Additional Materials:
   1. Fasteners: mechanical fasteners or adhesives only as specifically recommended for the application by the insulation manufacturer and meeting roof membrane manufacturer's system requirements.
   2. Protection Materials: opaque white coverings.

2.08 ACCESSORIES

A. Sheet Metal:
   1. General:
      a. Match existing components when possible. All replacement components to meet current code and industry standards for size, quality and applicability.

2. Product: Metal Flashings:
    a. Product: Sarnafil Metal Sheet.
    b. Description: Laminate of PVC membrane and galvanized steel. PVC Clad Metal:
    c. Usage: Provide monolithic watertight flashing metal at curbs and transitions as indicated in project drawings.
    d. Color: Reflective Gray.
    e. Galvanized Steel: 24 gauge.
    f. PVC Coating: 20 mil (0.020").

B. Drains:
    1. See Section 22 40 00 Plumbing Fixtures.

C. Vents / Sheet Metal Ductwork:
    1. See Division 23 - Heating, Ventilating, and Air Conditioning.
    2. See Section 07 60 00 – Flashing & Sheet Metal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify securely supported substrate, free of depressions, waves or projections.

B. Verify substrate surfaces are dry and free of moisture in any form.

C. Verify proper placement of roof openings, pipes, curbs, sleeves, ducts, vents, drains and other penetrations.

3.02 JOB AND WEATHER CONDITIONS

A. Suspend all application and installation activities during inclement weather.

B. Protect adjacent building surfaces against damage and adhesive/adherent spillage.

C. Do not permit traffic or material storage on completed roof surfaces.

D. Maintain proper application temperatures of all adherents, sealant etc.

3.03 ROOF BOARD INSTALLATION

A. Install roof boards per manufacturer's instructions, using only recommended fasteners and provided full support of edges and ends.

B. Board edges and ends shall be butted tightly together; do not gap edges or ends.

3.04 RIGID INSULATION INSTALLATION

A. Install rigid insulation per manufacturer's instructions, using only recommended fasteners and/or adhesives.

B. Install rigid insulation with a minimum slope in any direction of 1/4" per foot.

C. Trim insulation sheets to fit tightly, without gaps or birdmouths.

3.05 SUBSTRATE PREPARATION

A. Comply with membrane manufacturer's published instructions for preparation of substrates to receive roofing. Prior to priming, clean substrate of dust, debris, and other substances detrimental to roofing work.

B. Substrates must be adequately smooth and level to provide support and maximum contact surface for roofing materials. The surface must be dry, clean, and free of debris, sharp projections and depressions.

C. Complete, repair and/or replace and subsequently seal all openings, drains, vents, conduit or other projections through the deck prior to roof system installation.

3.06 SURFACE MEMBRANE

A. Insure installation of required membrane meets Class “A” fire rating.

B. No underlayment required.

C. Attaching Membrane:
   1. Ensure membrane is smooth and free of wrinkles or buckles.
   2. Carefully remove backing and adhere membrane in attachment sequence described in manufacturer's literature.
   3. Apply membrane as calculated by membrane manufacturer to meet with latest Factory 1-90 wind uplift criteria.

E. Seam Application:
   1. Allow membrane to relax one-half (1/2) hour.
   2. Fully weld all seams with approved adherent or adhesive.
   3. Allow seams to dry and check for voids or deficiencies.

F. Additional Attachment:
   1. Provide mechanical attachment where required by manufacturer's instructions at penetrations and or transitions.
   2. Mechanical fasteners shall provide a minimum of one hundred seventy-five (175) pounds pull withdrawal resistance.
   3. Any mechanical fasteners shall include recommended washers.

3.07 FLASHINGS

A. General:
   1. Allow membrane to fully cure prior to application of flashings. All surfaces to be adhered should be compatible, dry and smooth with no excessive surface roughness.
   2. All metal counterflashing shall be designed to completely cover and shield the flashing membrane a minimum of four (4) inches or as indicated in project drawings.

3.08 ACCESSORIES

A. Sheet Metal:
   1. Fabricate and install sheet metal according to Section 07 62 00 of these Specifications.
   2. Use only fabrication tecniques described in the SMACNA Architectural Sheet Metal Manual, current edition.
   3. Seal all metal joints watertight.
   4. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

B. Drains:
   1. Reference Contract Drawings & Roof Plan
   2. Reference drain manufacturers installation instructions.

C. Sealants:
   1. Apply sealants according to Section 07 92 00 of these Specifications.
   2. Apply sealants at all points of termination or other locations necessary to render the entire roofing assembly and related substrates watertight.

3.09 CLEANING

A. Upon the Substantial Completion of the Work, the Contractor shall remove all waste materials and rubbish from and about the Site, as well as all tools, construction equipment, machinery, and surplus materials and leave the Work “broom-clean” or equivalent.

B. Clean any drips or spills of roofing materials, accessories or other cosmetic deficiencies as noted by the Owners representative.

End of Section

Section 07 11 00

DAMPPROOFING

PART 1 – GENERAL

1-1. SCOPE. This section covers furnishing and installation of dampproofing for concrete.

PART 2 - PRODUCTS

2-1. MATERIALS. Materials to be used shall be as follows:

Coal Tar Epoxy	Ameron “Amercoat 78HB Coal Tar Epoxy, Carboline “Bitumastic 300 M”, Tnemec “46H-413 Hi-Build Tneme-Tar”, or Sherwin-Williams “Hi-Mil Sher-Tar Epoxy”
Emulsified asphalt	Henry “HE 107-Asphalt Emulson”
Epoxy Enamel	As specified in the Protective Coatings section
Membrane	Grace “Bituthene 3000 and Bituthene Low Temperature”

Emulsified asphalt shall be solvent free and made from asphalt emulsified with bentonite clay and water.

Membrane shall be a self-adhesive rubberized asphalt/polyethytlene waterproofing material with a minimum thickness of 1/16 inch (1.5 mm).

2-2. SURFACES TO BE DAMPPROOFED. Exterior wall surfaces which are poured against sheeting or undisturbed earth need not be dampproofed. The following concrete surfaces that are not in contact with treated or potable water shall be dampproofed:

a. All exterior concrete wall surfaces forming a part of an interior room or dry pit which will be in contact with earth backfill below finished grade and above the top of the footings or bottom slabs.

b. All exterior wall surfaces of cast-in-place and precast concrete electrical manholes and handholes below finished grade and above the top of the footings or bottom slabs.

c. All walls in contact with liquid where the opposite face is above grade or exposed in an interior room, except when waterproofing is specified.

PART 3 - EXECUTION

3-1. SURFACE PREPARATION. When dampproofing is applied, concrete surfaces shall be clean and dry. Except where membrane is applied, new concrete shall cure at least 28 days before dampproofing material is applied. Concrete shall be allowed to cure in accordance with the membrane manufacturer's recommendation before membrane damproofing is applied. Concrete shall be prepared to receive the damproofing material as recommended by materials manufacturer.

All dirt, dust, sand, grit, mud, oil, grease, and other foreign matter shall be removed in accordance with ASTM D4258 and the surface abraded when recommended by the manufacturer of the dampproofing material. Abrading shall be done in accordance with ASTM D4259. Prior to application of the coating, the surfaces shall be thoroughly washed, or cleaned by air blasting, to remove all dust and residue.

3-2. APPLICATION. Dampproofing materials shall not be thinned unless recommended by the manufacturer.

Surfaces not intended to be dampproofed shall be protected from contamination, discoloration, or other damage. Such surfaces shall be masked as necessary to protect uncoated areas and to confine the dampproofing to the intended limits.

Surfaces shall be dry and at recommended temperature when dampproofing is applied. Unless properly protected, coatings shall not be applied in wet, damp, or foggy weather or when windblown dust, dirt, or debris, or insects would collect on the coating. Dampproofing, other than low temperature membrane dampproofing, shall not be applied when the temperature of the air or the surface is below 50°F, unless approved by manufacturer. Low temperature membrane dampproofing may be applied at air and surface temperatures as low as 25°F if approved by manufacturer and acceptable to the Engineer.

Dampproofing shall be applied by brush, high pile rollers, or spray equipment complying with the manufacturer's recommendations. If blistering occurs, all blisters larger than 1/4 inch [6 mm] in diameter shall be broken before the subsequent coat is applied.

End of Section

Section 07 20 00

BUILDING INSULATION

PART 1 - GENERAL

1-1. SECTION INCLUDES

A. Thermal insulation at exterior wall assemblies.

B. Sound insulation at interior wall and ceiling assemblies.

1-2. RELATED WORK

A. Section 05 40 00 - Cold Formed Metal Framing

B. Section 09 25 00 - Gypsum Dryall

C. Section 13 34 19 - Metal Building Systems

1-3. REFERENCES

A. UBC Standard 8-1.

B. ASTM C 423, Type E-405 - sound absorption of materials

C. ASTM E 136 - flammability of materials

1-4. SUBMITTALS

A. Submit product data under provisions of Section 01 33 00.

1-5. CERTIFICATIONS

A. All insulation products shall be certified to contain no added formaldehyde, in compliance with CALGreen Tier 1 requirements.

1-6. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products per the manufacturer's published recommendations.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS

A. Owens-Corning, "Pink" Fiberglass Thermal Batts and "Quiet Zone" Sound Control Batts.

B. CertainTeed, "Sustainable" Fiberglass Thermal Batts and "Noise Reducer" Sound Control Batts.

C. Alternate products may be used on the basis of submittals made under provisions of Section 01 33 00.

2-2. THERMAL INSULATION

A. 5-1/2 inch kraft faced fiberglass thermal batts, at 5-1/2" metal stud exterior wall assemblies, as follows:
   1. Flame Spread: 25 or less; Smoke Density 450 or less.
   2. R-value: 21
   3. Vapor Barrier Maximum Perms: 1.00

B. 8-1/4" unfaced fiberglass thermal batts, at interior ceiling assemblies, as follows:
   1. Flame Spread: 25 or less; Smoke Density 450 or less.
   2. R-value: 30

2-3. SOUND INSULATION

A. 3-1/2 inch unfaced fiberglass sound attenuation batts at walls between occupied spaces, and at ceiling fire assemblies per Drawings, as follows:
   1. Flame Spread: 25 or less; Smoke Density 450 or less.
   2. Flammability Rating: Class A
   3. Insulation Value: R-11

PART 3 - EXECUTION

3-1. EXAMINATION

A. Verify that conduit, plumbing, and other installations in walls or insulated attic space have been completed, and necessary inspections have been made so that insulating may commence.

B. Beginning of work means acceptance of existing conditions.

3-2. EXTERIOR WALL INSULATION

A. Install faced batts with facing to interior side of wall.

B. Attach facing flanges to face of framing members per manufacturer's recommendations.

3-3. INTERIOR INSULATION

A. Install sound insulation batts at interior walls and ceilings as shown on Drawings.

B. Install batts friction fit between studs or joists. If stud spacing allows batts to slump, use wire to hold batts up in wall cavity.

3-4. CLEAN-UP

A. After completion of insulation installation, remove all scrap material, packaging, and debris from the work site.

End of Section

Section 07 60 00

FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Miscellaneous flashings and counterflashings as required to protect buildings from water penetration and which are not a part of pre-engineered metal building systems.

1.02 RELATED WORK

A. Section 05 40 00 - Cold-Formed Metal Framing

B. Section 07 50 00 - Membrane Roofing

C. Section 07 92 00 - Joint Sealants

D. Section 13 34 19 - Metal Building Systems

D. Division 22 - Plumbing

E. Division 23 - Heating, Ventilating, and Air Conditioning

1.03 REFERENCES

A. AA (Aluminum Association) - Aluminum Construction Manual: Aluminum Sheet Metal Work and Building Construction.

B. ANSI (American Iron and Steel Institute) - Stainless Steel - Uses in Architecture.

C. ANSI/ASTM B32 - Solder Metal.

D. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate.

E. ASTM A525 - Steel Sheet, Zinc Coated, (Galvanized) by the Hot-Dip Process.

F. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.

G. FS O-F-506 - Flux, Soldering, Paste and Liquid.

H. FS QQ-S-571 - Solder, Tin Alloy.

I. FS SS-C-153 - Cement, Bituminous, Plastic.

J. NAAMM - Metal Finishes Handbook.

K. NRCA (National Roofing Contractors Association) - Roofing Manual.

L. SMACNA - Architectural Sheet Metal Manual.

1.04 SYSTEM DESCRIPTION

A. Work of this Section shall be applied in a fashion which will physically protect roofing, exterior decks, exterior walls, openings in exterior surfaces, and exterior joints between materials from damage and water penetration that would permit water leakage to building interior.

1.05 QUALITY ASSURANCE

A. Design and Fabrication: In accordance with the standards and practices described in the SMACNA Architectural Sheet Metal Manual, latest edition.

B. Applicator: Company specializing in sheet metal flashing work with three years minimum experience.

1.06 SUBMITTALS

A. Submit shop drawings under provisions of Section 01 33 00 for any custom fabricated flashings.

1.07 STORAGE AND HANDLING

A. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation.

PART 2 - PRODUCTS

2.01 SHEET MATERIALS AND FLASHING PRODUCTS

A. Except where special flashings integral to products described elsewhere in these Specifications, design of flashings for the work is based on the use of galvanized steel sheet; aluminum or stainless steel sheet may be substituted as specified herein.

B. Galvanized Steel: ASTM A525, 26 gage minimum thickness core steel unless otherwise noted.

C. Aluminum Sheet: ASTM B209, 0.032inch minimum thickness, plain finish.

D. Stainless Steel: ASTM A167, Type 304, soft temper; 26 gage minimum thickness, smooth finish.

E. Roof, Wall or Soffit Attic Vents: as described on mechanical drawings.

2.02 ACCESSORIES

A. Fasteners: Galvanized steel, aluminum, stainless steel with soft neoprene washers at exposed fasteners; fastener of same material as flashing metal.

B. Underlayment: ASTM D266; No. 15 asphalt saturated roofing felt.

C. Metal Primer: per Section 09 90 00.

D. Protective Backing Paint: Zinc chromate alkyd.

E. Slip Sheet: Rosin sized building paper.

F. Sealant: Per Section 07 90 00.

G. Plastic Cement: FS SS-C-153, Type I-asphaltic base cement.

H. Solder: ANSI/ASTM B32.

I. Flux: FS O-F-506.

2.03 FABRICATION

A. General: Fabricate all flashings and sheet metal pieces shown or implied on the Drawings and which are not provided by the roofing contractor under Section 07 50 00, the pre-engineered metal building fabricator/installer under Section 13 34 19, or the mechanical contractor under Sections 22 00 00 and 23 00 00.

B. Form sections true to shape, accurate in size, square, and free from distortion or defects.

C. Fabricate any cleats or starter strips of same material as sheet, minimum 1 inch wide, inter- lockable with sheet.

D. Form pieces in longest practical lengths.

E. Hem exposed edges on underside 1/2 inch; miter and seam corners.

F. Form exposed-to-view material with flat lock cover plate seam.

G. Solder and seal metal joints. After soldering, remove flux, wipe and wash solder joints clean.

H. Unless otherwise indicated in Drawings, fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

2.04 FINISH

A. Paint over any holidays in galvanized finish resulting from fabrication, assembly, or installation, with galvanizing touch-up paint.

B. Back paint concealed metal surfaces with protective backing paint.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify any openings, curbs, pipes, sleeves, ducts, or vents through exterior construction assemblies are solidly set, can't strips in place, and nailing strips located.

B. Verify membrane termination and base flashings are in place, sealed, and secure.

C. Beginning of installation means acceptance of existing conditions.

3.02 PREPARATION

A. Field measure site conditions prior to fabricating work.

B. Install starter and edge strips, and cleats before starting installation.

C. Secure flashings in place using concealed fasteners recommended in SMACNA manual. Use exposed fasteners only in locations approved in advance by Architect.

D. Lap, cleat, or seam and seal all joints.

E. Apply plastic cement compound between metal flashings and felt flashings.

F. Fit flashings tightly in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

G. Seal metal joints watertight.

3.03 INSTALLATION

A. Conform to details and profiles as indicated on approved shop drawings and comply with SMACNA standard practices.

B. Replace any exposed-to-view installations which become dented, warped, or "oil canned" by actions of flashing and sheet metal fabricators or installers, at no additional cost to Owner.

C. In place repairs of damaged flashing or sheet metal shall only be as authorized and approved by the Construction Superintendent.

D. Install reglets and counterflashings according to manufacturer's instructions.

3.04 CLEAN UP

A. After completion of flashing and sheet metal installation, remove any excess sealant, cement, or solder from exposed-to-view surfaces.

B. Remove metal scraps, excess fasteners, and related debris from job site.

End of Section

Section 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1-1. SCOPE. This section covers caulking and sealing. Fire rated caulking is covered in the Fireproofing section.

1-2. GENERAL. The terms "caulking" and "sealing", as used on the Drawings and in these Specifications, are synonymous. Both terms indicate the materials specified herein. Oil-base caulking shall not be used on this Project.

1-3. APPROVALS. All caulking shall meet the requirements of the standards specified herein. All caulking and sealing to be used in contact with potable water shall meet the requirements of ANSI/NSF Standard 61.

1-4. SUBMITTALS. Specifications and data covering the materials proposed for use, together with samples or color cards showing the manufacturer's full line of sealant colors, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. MATERIALS.

Thiokol Sealants (polysulfides)	Fed Spec TT-S-00227E, Class A or ASTM 920 Type M; polysulfide rubber, two component.
Nonsag	
Submerged Service, Non potable water	Pecora "Synthacalk GC-2+".
Nonsubmerged Service Service	Pecora "Synthacalk GC-2+"; Polymeric Systems “PSI-350”.
Self-Leveling, nonsubmerged	A. C. Horn "Hornflex Traffic Grade"; Polymeric Systems “PSI-350”.
Urethane Sealants (Polyurethanes)	Fed Spec TT-S-00227E, Class A, Type 2 and ASTM C920, Type M, Grade NS, two component.

Nonsag	
Submerged Service	
Potable Water	Polymeric Systems “RC-270”; Sika “Sikaflex-2cNS.
Nonpotable Water	Polymeric Systems “RC-270".
Nonsubmerged Service Service	Bostik "Chem-Calk 500"; Tremco "Vulkem 227"; Pecora "Dynatrol II"; Tremco "DYmeric 240"; Sika “Sikaflex-2cNS”.
Self-Leveling, Nonsubmerged Service	Bostik "Chem-Calk 550"; Tremco "Vulkem 245"; Pecora "Urexpan NR-200"; Polymeric Systems “ RC-2SL"; Tremco "THC-900".
Acrylic Sealant	Fed Spec TT-S-230; ASTM C834.
	Bostik “Chem-Calk 600”; Pecora “ AC20”; Tremco “Mono 555”.
Silicone Sealant	Silicone rubber, neutral color; Dow Corning "Mildew-Resistant silicone 786"; General Electric "Silicone Sanitary 1702 Sealant".
Primer	As recommended by the sealant manufacturer.
Backup Material	Polyethylene or polyurethane foam as recommended by the sealant manufacturer; Dow "Ethafoam SB" or Plateau "Denver Foam".
Bondbreaker Tape	Adhesive-backed polyethylene tape as recommended by the sealant manufacturer.

2-2. COLORS. Colors of sealants shall be as selected by Design-Builder from the manufacturer's standard line of colors. Different colors may be required for different locations.

2-3. LOCATIONS TO BE CAULKED.

2-3.01. With Thiokol or Urethane Sealant (Nonsag) - Submerged Service

All joints requiring caulking in submerged locations.

Surface of basin weir plates in contact with supporting structure.

2-3.02. With Thiokol or Urethane Sealant (Nonsag) - Nonsubmerged Service.

Entire perimeter of frames for exterior metal or fiberglass doors.

Entire perimeter of metal louvers.

Entire perimeter of aluminum windows.

Control joints in masonry walls.

Perimeter of aluminum entrances and assemblies, except exterior side of exterior sills.

Around service sinks.

Joints between masonry and cast-in-place concrete, where indicated on the Drawings.

Other locations where caulking is indicated on the Drawings, specified in other sections, or required for weatherproofing.

2-3.03. With Thiokol or Urethane Sealant (Self-Leveling).

Horizontal joints in walks or drives.

Horizontal joints in traffic-bearing decks and slabs.

Annular space around handrail posts set in sleeves**.**

2-3.04. With Acrylic Sealant.

Watertight joints in sheet metal work.

2-3.05. With Silicone Sealant. (Not used)

PART 3 - EXECUTION

3-1. JOINT PREPARATION. All surfaces to receive sealant shall be clean, dry, and free from dust, grease, oil, or wax. Concrete surfaces which have been contaminated by form oil, paint, or other foreign matter which would impair the bond of the sealant to the substrate shall be cleaned by sandblasting. All surfaces shall be wiped with a clean cloth saturated with xylol or other suitable solvent, and shall be primed before the sealant is applied.

Unless otherwise recommended by the sealant manufacturer and permitted by the Engineer, the depth of sealant in a joint shall be equal to the width of the joint, but not more than 1/2 inch. Backup material shall be provided as necessary to control the depth of sealant and shall be of suitable size so that, when compressed 25 to 50 percent, the space will be filled. Backup material shall be rolled or pressed into place in accordance with the manufacturer's installation instructions, avoiding puncturing and lengthwise stretching. If depth of the joint does not permit use of backup material, bondbreaker tape shall be placed at the bottom of the joint to prevent three-sided adhesion.

3-2. SEALING. Sealing work shall be done before any field painting work is started. The air temperature and the temperature of the sealed surfaces shall be above 50°F when sealing work is performed.

Upon completion of the sealing work, each sealed joint shall have a smooth, even, tooled finish, flush with the edges of the sealing recess, and all adjacent surfaces shall be clean. Sealant shall not lap onto adjacent surfaces. Any sealant so applied as to prevent the painting of adjacent surfaces to a clean line, or with an excess of material outside the joint and feathered onto surfaces, shall be removed and the joint resealed.

End of Section

Section 08 10 00

METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Rated and non-rated interior rior steel doors.

B. Rated and non-rated interior steel door frames.

1.02 RELATED WORK

A. Section 05 40 00 – Cold Formed Metal Framing.

B. Section 08 40 00 – Storefront Systems.

C. Section 08 70 00 – Door Hardware.

D. Sectioin 09 25 00 - Gypsum Drywall.

E. Section 09 90 00 – Painting.

1.03 REFERENCES

A. Steel Door Institute Standard SDI-100 - Standard Steel Doors and Frames; SDI 105 - Recommended Erection Instructions for Steel Frames.

B. ASTM A653 - Standard for Hot Dipped Galvanized Steel Material.

C. UL 10B Fire test of Door Assemblies and UL10C Standard for Positive Pressure Fire Tests of Door Assemblies.

D. NFPA-101 - Life Safety Codes (Latest Edition).

1.04 QUALITY ASSURANCE

A. Conform to referenced standards for door and frame constuction and installation.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 30 00.

B. Indicate door elevations and frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement, priming and finishing options.

1.06 DELIVERY, STORAGE AND HANDLING

A. Upon delivery, inspect all materials for damage; notify shipper and supplier if damage is found.

B. Protect products from moisture, construction traffic, and damage.
   1. Store vertically under cover.
   2. Place units on 4 inch (102 mm) high wood sills or in a manner that will prevent rust or damage.
   3. Do not use non-vented plastic or canvas shelters.
   4. Should wrappers become wet, remove immediately.
   5. Provide 1/4 inch (6 mm) space between doors to promote air circulation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS – RATED AND NON-RATED STANDARD STEEL DOORS AND FRAMES

A. Steelcraft, Republic.

B. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 STEEL DOORS (see Door Schedule and Door Types)

A. Interior Flush Panel Door
   1. Design: Steelcraft L Series full flush steel or equivalent.
   2. Metal Thickness: 18 gauge.
   3. Door Thickness: 1-3/4 inches.
   4. Core: 1” honeycomb.
   5. View Lites: Dezigner Trim recessed, mitered trim, glazing by others.
   6. Louvers: Anemostat AFDL, size per drawings, primed for field painting.
   7. Labeling: 90 minute, per Door Schedule.
   8. Hardware Preparation: cylinder lockset bore (see Section 08 70 00).
   9. Finish: rust inhibitive primed finish for field painting.

2.03 STEEL FRAMES (see Door Schedule and Frame Types)

A. Rated Interior Frames for Metal Doors
   1. Design: Steelcraft DW Series mitered frames at drywall partitions.
   2. Metal Thickness: 16 gage.
   3. Face Dimension: 2 inches.
   4. Labeling: 90 minute, per Door Schedule.
   5. Anchoring: metal stud anchors.
   6. Finish: rust resistant primed finish for field painting.

2.04 MATERIALS

A. Doors, frames, frame anchors, and hardware reinforcings for each of the levels and models specified shall be provided to meet the requirements of the

performance levels specified. The material used in manufacturing these products and components shall comply with ANSI/SDI A250.8. Hardware reinforcing on doors and frames shall comply with ANSI/SDI A250.6. The physical performance levels shall be in accordance with ANSI/SDI A250.4.

B. All steels used to manufacture doors, frames, anchors, and accessories shall meet at least one or more of the following requirements:
   1. Cold rolled steel shall conform to ASTM A1008 and A568.
   2. Hot rolled, pickled and oiled steel shall comply with ASTM A1011 and A568.
   3. Hot dipped zinc coated steel shall be of the alloyed type and comply with ASTM A924 and A653.
   4. Steel Sheet, Electrolytic Zinc-Coated shall conform to ASTM A591.

2.05 PREPARATION

A. Prepare doors and frames to receive door hardware as approved through the submittal process, providing all necessary reinforcement or backing.

B. Confirm that approved locksets/latchsets will fit within stiles of doors with proposed backset dimension. Bring any conflicts to the attention of the Architect for resolution prior to door preparation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install metal doors and frames in accordance with SDI standards.

3.02 TOLERANCES

A. Maximum Diagonal Distortion: 1/8 inch measured with straight edge, corner to corner.

3.03 ADJUSTING AND CLEANING

A. Adjust hardware for smooth and balanced door movement.

B. Replace any metal doors or frames which are, in the opinion of the Owner, unacceptably dented, scraped, or otherwise damaged, at no additional cost to the Owner. Repairs to damaged doors shall only be allowed if acceptable to the Owner's representative.

End of Section

Section 08 15 40

FIBERGLASS DOORS AND FRAMES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fiberglass reinforced plastic (FRP) Doors.

B. Fiberglass reinforced plastic (FRP) Frames.

C "FRP" is defined as fiberglass reinforced polyester.

1.02 RELATED SECTIONS

A. Section 08 70 00 - Door Hardware.

B. Section 08 80 00 - Glass and Glazing.

C. Section 09 90 00 - Paints and Coating.

D. Section 13 34 19 - Metal Building Systems.

1.03 QUALITY ASSURANCE

A. General: Provide fiberglass reinforced door and frame units made of components of standard construction furnished by one manufacturer as coordinated assemblies.

B. Manufacturer: Company specializing in the manufacture of fiberglass doors and frames with a minimum of five years documented experience.

C. Construction: Verify that FRP doors and frames are manufactured utilizing pultruded fiberglass components for flexibility, durability, superior strength and chemical resistance. Press-molded doors and frames will not be accepted. Resin rich door edges and gelcoat are prone to chipping and cracking (brittle).

D. Resins: Resins shall comply with USDA and FDA standards for incidental food contact.

E. Flame Spread Rating: Flame retardant structural shapes meet the minimum flame spread rating less than or equal to 25 when tested according to ASTM E84.

F. Impact Strength: FRP doors and panels 10.32 foot-pounds per inch of notch, ASTM D-256.

G. Tensile Strength:

1. FRP doors and panels 12,000 psi, ASTM D-638.

2. FRP frames 30,000 psi, ASTM D-638.

I. Flexural Strength: FRP doors, panels, and frames 25,000 psi, ASTM D-790.

J. Compressive Strength:

1. FRP doors and panels 18,000 psi, ASTM D-695.
2. FRP frames 30,000 psi, ASTM D-695.

K. Water Absorption: FRP doors, panels, and frames .27 %, ASTM D-570.

L. Hardware Reinforcements: FRP doors and frames fabricated with a minimum screw holding strength of 1,000 lbs. tested with a #12 x 1-1/4" hinge screw.

M. Paint Adhesion: Coating for FRP doors, panels, and frames to conform to AAMA 624-07 for color uniformity, film adhesion, specular gloss, direct impact, abrasion resistance, and chemical resistance.

N. Warranty: Warranty fiberglass doors and frames for life of the initial installation against failure due to corrosion. Additionally, warrant fiberglass doors and frames for a period of 10 years against failure due to materials and workmanship, from date of substantial completion.

1.04 SUBMITTALS

A. Make Submittals in accordance with Section 01 33 00.

B. Shop Drawings including the following information:

1. Specifications relating to FRP door thickness, resin type, core material, method of construction, finish color, type of glass and glazing, anchor systems, joint construction, and complete warranty information.
2. Complete schedules or drawings of FRP doors and frames and associated Builders Hardware showing identifying mark numbers, door and frame types, typical elevations, nominal sizes, handing, actual dimensions and clearances, and required hardware preparations and reinforcement.
3. Supporting reference drawings pertaining to frame mounting details, door light or louver installation, hardware locations, factory hardware cutouts and reinforcements.

C. Color Samples: Provide a complete set of available finish colors from the manufacturer for color selection upon request.

D. Installation instructions: Include manufacturer's specific information describing procedures, sequence and required fasteners for frame and door installation.

E. Production of FRP doors and frames shall not proceed until submittals, including all necessary manufacturing information, are approved.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage exists.

C. Store doors and frames at building site under cover, in a vertical position, clear of the floor, with blocking between the doors to permit air circulations between the doors and prevent damage to door faces. Do not allow water or condensation to collect or stand between stored doors. Do not wrap doors in plastic sheeting or other materials that could create a humidity chamber.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Overly Door Company: 574 West Otterman Street; Greensburg, PA, 15601-0070; Tel: 800-979-7300.

a. Product Line: Tiger Door FRP.

2. Equivalent products of other manufacturers will be accepted on the basis of Submittals in accordance with Section 01 33 00.

2.02 DOORS

A. Non-Rated FRP Doors:

1. Heavy Duty fiberglass door and frame assembly, seamless press-molded construction with 0.120" pre-molded FRP face sheets, all integrally fused with no reliance on adhesives.

2. Fiberglass tube stiles and rails.

3. Core: Phenolic impregnated Kraft honeycomb core.

4. Face sheets: USDA-rated non-porous, flame spread rating 200, smoke generated 450, Class C per ASTM E84.

5. Finish: Factory applied 4 mils two-part aliphatic polyurethane, industrial formula, with H to 2H minimum hardness, semi-gloss, color as selected by the Architect from the full range of manufacturer's stock and optional colors.

6. Vision lights: Factory furnished, glazed and installed, with pultruded FRP glazing stops, all caulking concealed.

7. Door Louvers: Factory furnished and installed, inverted V-blade, minimum fiberglass content 50%, coated to match door finish, sealed in place same as door lights.

2.03 FRAMES

A. General: Provide pultruded fiberglass frames for doors, transoms, side lights and borrowed lights, where indicated.

B. Non-rated Frames:

1. Comply with the requirements of grade specified for corresponding doors, profiles to match typical hollow metal configurations.

2. Mitered and blind-reinforced with hidden FRP angle clips and concealed fasteners.

3. Chemically welded FRP hardware reinforcements, minimum screw pullout strength 1,100 lb. per #12 x 1" sheet metal screw.

4. Anchors: Manufacturer's required number of 3/8" dia x 4" long flat head stainless steel sleeve anchors for masonry and concrete openings, #14 x 4" stainless steel flat head sheet metal screws for wood or steel stud openings. Include extra anchors for additional frame height in two-foot increments above 8 feet. Provide single bolt anchor at center of all headers over 4 feet nominal width. Stainless steel fasteners shall be factory-furnished.

5. Frame finish: Match door finish application, color and gloss.

C. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.

2.04 FABRICATION

A. General: Fabricate fiberglass door and frame units to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Core Construction: Manufacturer's standard core construction that complies with the following:

1. E-S (standard) series to have expanded polystyrene foam core.

2. E-P (premier) series to have full height vertical fiberglass stiffeners, 6 inches on center. Voids to be filled with expanded polystyrene foam.

3. E-C (custom) series to have expanded polystyrene foam, polyurethane foam or vertical fiberglass stiffeners, where indicated.

4. Hollow/honeycomb core will not be accepted.

C. Stiles and Rails: Fabricate doors utilizing heavy duty pultruded fiberglass tubular members.

D. Door Faces: Laminated composite faces shall be urethane fused to the stile and rail assembly, including the vertical stiffeners and core material, utilizing a two-

part 100 percent reactive urethane adhesive, and then cured under pressure until completely bonded.

E. Clearances: Not more than 1/8 inch (3.2 mm) at jambs and heads, except not more than 1/4 inch (6.4 mm) between pairs of doors. Not more than 3/4 inch (19 mm) at bottom, with standard being 5/8 inch (15.9 mm) at bottom.

F. Door Edges: Lock stile shall be factory beveled 1/8" in 2" for rub-free operation. Square lock-edge will not be accepted.

G. Tolerances: Maximum diagonal distortion - 1/16 inch (1.6 mm) measured with straight edge, corner-to-corner.

H. Exposed Fasteners: Unless otherwise indicated, provide stainless steel, countersunk flat or oval heads for exposed screws and bolts.

I. Thermal-Rated (insulating) Assemblies: At exterior locations and elsewhere shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies, with an "R" value of 11-12.

J. Hardware Locations: Locate hardware as indicated on shop drawings or if not indicated, according to manufacturers standard locations.

K. Astragals: Fabricate astragals for pairs of doors utilizing fiberglass materials in either flat or "T" configuration where indicated.

2.05 FINISHES

A. Prime Finish: Where job finished doors are scheduled, pre-clean and shop prime each door and frame ready for finish painting, performed at the jobsite under Section 09900.

B. Factory Finish: Where factory finished doors are scheduled, furnish fiberglass doors and frames factory pre-finished.

1. Finish: Manufacturers standard chemical resistant two-part polyurethane topcoat.
2. Sheen: Satin or semi-gloss - as indicated.

B. Door Faces: Face skins shall be smooth. Slightly textured gelcoat facings will not be accepted.

C. Finish on fiberglass frames must match that of the fiberglass doors to which they are installed. Gelcoated doors and polyurethane coated frames together as a unit will not be accepted.

2.06 HARDWARE

A. Hardware: All hardware shall be furnished under Section 08 70 00, unless stated otherwise.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Factory mark all doors and frames using a chemical resistant plastic tag or indelible marking with identifying number, keyed to shop drawings, prior to shipment. Factory door marks shall not be visible in the finished installation.

B. General: Install fiberglass doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.

C. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
2. In masonry construction, provide at least three wall anchors per jamb; install adjacent to hinge locations on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
3. In existing concrete or masonry construction, provide at least three completed opening anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with stainless steel expansion bolts and masonry anchorage devices.
4. For openings 90 inches (2286 mm) or more in height, install an additional anchor at hinge and strike jambs.

C. Factory Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

D. Door Installation: Fit fiberglass doors accurately in frames. Shim as necessary.

3.02 ADJUSTING AND CLEANING

A. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

B. Cleaning: Clean fiberglass door and frame assemblies in accordance with manufacturer's recommended procedure.

End of Section

Section 08 33 10

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Exterior manual and motor operated coiling overhead doors.

1.02 RELATED WORK

A. Section 05 10 00 - Structural Steel.

B. Section 13 34 19 - Metal Building Systems.

1.03 REFERENCES

A. ANSI A216.1 - Sectional Overhead Type Doors.

B. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in the construction of overhead doors, with a minimum of three years experience.

B. Installer: Company skilled in the installation of overhead doors and approved by the manufacturer for the installation.

1.05 SUBMITTALS

A. Submit shop drawings, product data and manufacturer's installation instructions under provisions of Section 01 33 00.

B. Indicate opening dimensions and tolerances, component construction, connections and details, anchorage methods and spacing, hardware and locations, installation details, and available options.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 79 00.

B. Include data for lubrication frequency, control adjustments, and spare part sources.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in labeled protective packages. Protect products during delivery, storage, and handling to prevent damage to mechanism or slats.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Raynor Garage Doors.

B. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 INTERIOR OVERHEAD ROLLING CURTAIN DOORS

A. Model: Duracoil Model "Standard".

B. Slats: Type FF, 2-9/16" X 25/32" flat profile, hot dip galvanized steel.

C. Guides and Brackets: inside face mounted, galvanized steel with brush seals.

D. Counterbalance: Enclosed, helical torsion springs.

E. Bottom Bar: Galvanized steel angle with neoprene floor seal.

F. Operation, Manual: Pull chain.

G. Operation, Motorized: bracket mounted 3-phase electric motor, operated with manual chain override. Furnish push button controls both sides of door.

H. Hood: 24 gauge galvanized steel sheet.

I. Lock: slide bolt with padlock hasp.

J. Mounting: inside face of wall.

K. Slat Finish: Two coat baked primer for field painting.

L. Quantity/Size: refer to Drawings.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that wall openings are ready to receive the products of this Section and that opening dimensions and tolerances are within manufacturer's allowable limits.

B. Beginning of installation means acceptance of existing surfaces.

3.02 PREPARATION

A. Prepare opening to permit correct installation of door units and attachments.

3.03 INSTALLATION

A. Install door assembly in strict accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten door assembly to structural frame without distortion or stress.

C. Fit and align door assembly level and plumb to provide smooth operation.

D. Coordinate installation of sealants and backing materials at frame perimeter in accordance with Section 07 92 00.

3.04 INSTALLATION TOLERANCES

A. Maximum allowable variation from plumb: 1/8" overall.

B. Maximum allowable variation from level: 1/8" overall.

C. Maximum allowable longitudinal or diagonal warp: 1/8" maximum in 10 feet.

3.05 ADJUSTING AND CLEANING

A. Adjust for smooth and balanced door movement.

B. Remove labels and markings from exposed-to-view surfaces.

C. Clean slats and housings thoroughly with manufacturer's recommended products.

D. Touch up damaged coatings and finishes and repair minor damage to satisfaction of Owner's Representative.

End of Section

Section 08 40 00

STOREFRONT SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Aluminum storefront framing system.

B. Aluminum entry doors.

C. Aluminum sun control devices.

1.02 RELATED WORK

A. Section 08 10 00 - Metal Doors and Frames.

B. Section 08 15 40 - Fiberglass Doors and Frames.

C. Section 08 80 00 - Glass and Glazing.

1.03 REFERENCES

A. ASTM E283-04 - air infiltration.

B. ASTM E331-00 (2009) - water penetration.

C. AAMA 1502 and 1503 - glazing performance.

D. ASTM B221-08 - aluminum alloy for extruding.

E. AAMA 605.2 - high performance specification for organic coatings on aluminum extrusions.

1.04 REFERENCE DOCUMENTS

A. Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of this Section where cited by abbreviations noted below.
   1. American Society for Testing and Materials (ASTM).
   2. The Aluminum Association's "Designation System for Aluminum Finishes" (AA).
   3. American Architectural Manufacturers Association's
      a. "Methods for Test for Metal Curtain Walls" (AAMA 501-83).
      b. "Field Check of Metal Curtain Walls for Water Leakage" (AAMA 501-2-83).
   4. California Building Code, 2010 Edition.

1.05 QUALITY ASSURANCE

A. Design Criteria for Storefront System
   1. Drawings show external profiles required. Minor modifications for better water tightness or greater strength may be proposed for the Architect's approval.
   2. Storefront framing system shall conform to CBC 1609 for wind load criteria.
   3. Performance Standards for Storefront System:
      a. Thermal Movement: Construct storefront system to proved for expansion and contraction of component materials as will be caused by ambient temperature ranging from 10 to 120 degrees Fahrenheit without causing buckling, opening of joints, glass breakage, undue stress of fasteners, or other detrimental effects.
      b. Air Infiltration: Do not exceed 0.06 cubic feet per minute per square foot of fixed wall area plus permissible allowance for operable windows within test areas when wall is tested in accordance with ASTM E283-04.
      c. Water Infiltration:
         1) Water infiltration is defined as appearance of water other than condensation on inside face of any part of the storefront system.
         2) Make provisions to drain to exterior face of wall any water leakage and condensation occurring within storefront system construction.
         3) Water Infiltration: None when system is tested in accordance with ASTM E331-00 at test pressure of 7.5 psf.
      d. Structural:
         1) Design storefront system to withstand 40 psf wind load acting inward (positive pressure) and outward (negative pressure) with both wind loads acting normal to plane of storefront system.
         2) Deflection Normal to Storefront Plane: Do not exceed 1/175 of clear span of any metal framing member when tested in accordance with AAMA 501-83, Test for Structural Performance.
         3) Deflection Parallel to Wall Plane: When carrying full design load to not exceed 75 percent of design clearance dimension between that member and panel, glass, or other part immediately below it.

1.06 SUBMITTALS

A. Structural Calculations and Details: Show that the storefront framing system meets CBC wind load requirements. Such calculations and details must be approved by the Architect and (if required) the City of Morro Bay prior to fabrication.

B. Shop Drawings:
   1. Show storefront framing system and details including component parts, and attachments or junctions with adjacent work.

2. Show construction of all components including metal, glass, weather-stripping, and similar items.
3. Show finishes, sealant brands and all other information showing compliance with specifications.
4. Show proposed locations of nay exposed fasteners.

C. Product Data.

D. Samples: Color samples for approval of hue and sheen.

E. Test Reports:
1. Test reports to be from qualified, certified, independent testing agency.
2. Tests shall have been performed after January 1, 2001 on assemblies identical to those proposed for this project. The actual assemblies required for this project may be larger than the tested assembly, provided calculated deflection and set does not exceed maximum specified when applying "effective" moment(s) of inertia and section properties of window wall elements obtained from test of smaller units.
3. Submit test reports for each window wall performance standard specified.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver and store packaged products in original containers or bundles with seals unbroken and labels intact until time for use.

B. Keep materials dry. Where necessary, stack materials off ground on level flat forms, fully protected from weather.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - STOREFRONT SYSTEMS

A. Kawneer Company

B. U.S. Aluminum Corporation

C. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 STOREFRONT PRODUCTS

A. Storefront Framing System: Kawneer Trifab VG 451 components, with the following characteristics:
1. All components must the products of the same manufacturer.
2. Frame Dimensions: 2 inch X 4-1/2 inch; ADA bottom rail.
3. Material: 6063-T5 aluminum alloy.
4. Glazing Location: Center, insulated glazing units.
5. Assembly Type: Stick.

6. Finish: Permafluor fluoropolymer coating, as selected by Architect from standard range.

B. Aluminum Entry Doors: Kawneer 350 Medium Stile standard full dual glazed storefront entry door, with the following characteristics:
   1. Entry doors must be products of the same manufacturer as storefront system.
   2. Material: 6063-T5 aluminum alloy.
   3. Stiles: 1-3/4 inch X 3-1/2 inch.
   4. Top Rails: 1-3/4 inch X 3-1/2 inch.
   5. Bottom Rails: ADA compliant, 1-3/4 inch X 10 inch.
   6. Finish: Permafluor fluoropolymer coating, as selected by Architect from standard range.
   7. Door Hardware: per Section 08 70 00.
   8. Glazing: center, insulated units.

C. Aluminum Sun Control Devices: Kawneer Versoleil outrigger system, with the following characteristics:
   1. Sun control devices must be products of the same manufacturer as storefront system.
   2. Material: 6063-T5 aluminum alloy.
   3. Projection: 30 inches.
   4. Fascia: Rectangular.
   5. Outriggers: Square.
   6. Blades: Airfoil.
   7. Finish: Permafluor fluoropolymer coating, as selected by Architect from standard range.

2.03 ACCESSORIES

A. Storefront Connectors and Stiffeners: manufacturer's standard product as approved through submittal process.

B. Sealants for Use Within Storefront System Assemblies: Tremco's "Small Joint Sealer" or Seam Sealer"; or approved equal.

C. Weatherstripping: manufacturer's standard application as approved through submittal process.

D. Compressive Tape Filler: Closed cell, black neoprene tape conforming to ASTM C509-84, size as noted, with adhesive system as recommended by the manufacturer.

2.03 FABRICATION

A. Fabricate aluminum in accordance with referenced standards and good trade practice for commercial or institutional storefront applications.

B. Coordinate details with details of adjacent work to assure water tightness, proper attachments, sealed joints, tight flashings, and clean junctions.

C. Metal-to-Metal Joints Between Members: Insure water tightness by setting in mastic recommended by approved window wall manufacturer; remove excess prior to hardening.

D. Provide reinforcement as required.

E. Conceal welds and fasteners wherever possible.

F. Do not label exposed portions with trade or manufacturer's name.

G. Fabricate doors and frames allowing for minimum clearances and shim spacing around perimeter of asembly, yet enabling installation.

H. Provide permanent protection between dissimilar metals.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine openings to receive storefront system and verify that openings are plumb, level, clean, in full accord with contract documents and provided solid anchoring surface.

B. Do not start erection until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install aluminum in accordance with manufacturer's recommendations.

B. Make flashings absolutely watertight.

C. Lead collected moisture or water to outside as directly as possible.

D. Waterproof joints from back as required.

E. Employ only skilled workers, especially trained and experienced in this work.

F. Whenever aluminum comes into direct contact with steel, masonry, concrete, or non-compatible materials, separate them by bituminous paint, zinc chromate primer, or suitable insulating materials.

G. Plumb and align storefront faces in a single plane for each wall plane. Erect storefront system and materials square, true, and adequately anchored to maintain positions permanently when subjected to normal thermal and building movement and specified wind loads.

H. Coordinate storefront framing installation with security screen installation. Bring any conflicts to the attention of the Architect before proceeding.

3.03 ADJUSTING AND CLEANING

A. After completion of glazing and finish painting of surrounding surfaces, verify watertight conditions and make corrections as required.

B. Clean aluminum using only products specifically recommended by the manufacturer.

3.04 PROTECTION

A. Protect work from damage to surface, profile, and shape during and after erection and until project is accepted.

3.05 FIELD QUALITY CONTROL

A. Water Penetrations Tests: After completion of the installation and nominal curing of sealants, and before installation of interior trim members, test for water leaks in accordance with AAMA 501.2. Repair or replace any components, including joints and sealants, which leak or are observed to be defective in any way, and retest as directed.

End of Section

Section 08 51 13

METAL WINDOWS

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Aluminum exterior windows.

1.02 RELATED WORK

A. Section 05 40 00 - Cold Formed Metal Framing

B. Section 07 92 00 - Joint Protection

C. Section 09 25 00 - Gypsum Drywall

D. Section13 34 19 - Metal Building Systems

1.03 REFERENCES

A. AAMA/WDMA/CSA101/I.S.2/ A440-08- Structural and Leakage Performance.

B. ASTM D4726-09 - Vinyl Extrusions for Windows

C. California Administrative Code Title 24 for infiltration.

1.04 SUBMITTALS

A. Reference Section 01 33 00 - Submittal Procedure; submit following items:
   1. Product Data: Submit Wintech product data.
   2. Shop Drawings: Include window schedule, elevations, sections, details, & multiple-window assembly details. Include head, sill & jamb conditions; operable parts & direction/handing; and special mullion reinforcement details.
   3. Samples: Submit selection samples for verification, include the following:
      a. Exterior Color: Minimum 1x4 color chips on aluminum substrate.

B. Quality Assurance/Control Submittals:
   1. Qualifications: Proof of Manufacturer's qualifications.
   2. U-Factor and Structural Rating charts required for NFRC and AAMA labeling requirements.

3. Installation Instructions: AAMA 2400, (“Mounting Flange Installation”) or AAMA 2410 (“Flush Fin Installation”).

C. Closeout Submittals: Submit following items:
   1. Temporary window labels to identify windows that labels were applied to.
   2. Owner’s Manual/Maintenance Instructions.
   3. Special Warranties.

1.05 QUALITY ASSURANCE

A. Overall Standards: Comply with ANSI/AAMA/101/I.S.2, except where noted herein.

B. Manufacturer Qualifications:
   1. Minimum 10 years experience in producing vinyl windows.
   2. Member AAMA & NFRC.

C. Regulatory Requirements and Approvals:

D. Certifications for Insulated Glass Units:
   1. Insulated glass units are certified to ASTM E2188/E2190 per the Associated Laboratories Incorporated (ALI) guidelines.

E. AAMA: Windows shall be Gold Label certified with label attached to frame per AAMA requirements.

F. NFRC: Windows shall be NFRC certified with temporary U-factor label applied to glass and an NFRC tab added to permanent AAMA frame label.

1.06 DELIVERY, STORAGE AND HANDLING

A. Protect window products with resilient corner protectors and complete plastic wrapping; do not remove until installation.

1.07 WARRANTY

A. Provide a manufacturer's warranties:
   1. Workmanship: Limited one (1) year warranty against defects in materials and workmanship including costs for replacement parts and labor.
   2. Insulating Glass Units: Limited five (5) year warranty against material obstruction of vision as a result of dust or film formation on the internal glass surfaces.

PART 2 - PRODUCTS

2.01 EXTERIOR ALUMINUM WINDOWS

A. Acceptable Manufacturers:
   1. Wintech.
   2 Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

B. General Requirements: Fixed and Projected Window Characteristics:
   1. Product Model: Wintech S250.
   2. Material: 6063-T5 or T6 extruded aluminum, minimum wall thickness .062".
   3. Glazing: 1" dual pane glass, clear; tempered where required by code, as scheduled in the Drawings.
   4. Finish: Baked polyester paint meeting AAMA Guide Specification 2603-98, color as selected by Architect from standard range.
   5. Construction: Mechanically fastened and gasketed corners.
   6. Weatherstrip: Dual durometer vinyl bulb.
   7. Locks: White bronze cam handles.
   8. Screens: Manufacturer's fiberglass screens.
   9. Shapes/Sizes: per Drawings.
   10. Air Infiltration Limit: <0.15 cfm/ft @ 1.57 psf.
   11. Water Resistance: 0 leakage @ 12.5 lb.

PART 3 - EXECUTION

3.01 INSPECTION

A. Prior to the installation of metal windows, carefully inspect the completed work of all other trades and verify that all such work is complete to the point where this installation may properly proceed.

B. Confirm that metal windows can be installed in compliance with all pertinent codes and regulations, the original design, and the manufacturer's recommendations.

C. Coordinate carefully with pre-engineered metal building components and details to assure a compatible and leak-free installation.

D. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Install all metal windows in strict accordance with details shown in the Drawings and the the window manufacturer's published recommendations, and the pre-engineered metal building system manufacturer's recommendations, anchoring all components firmly into position.

B. Set metal windows in a continuous bead of exterior rated sealant, applied per sealant manufacturer's instructions and Section 07 92 00 of these specifications.

C. Install screens and seat screen frames securely in window channels.

3.03 CLEAN-UP AND ADJUSTMENT

A. After completion of metal window installation, remove packaging and debris from the work site.

B. Just prior to final completion, remove all labels, packing slips, and safety markings from glass. Use only cleaners recommended by the manufacturer.

C. Hose test all windows after installation to confirm water-tightness. Notify Owner of timing of water tests. Repair or replace any window components, flashings, sealants or other parts of installation as required to achieve water-tightness.

D. Adjust operable window components to move smoothly and easily and to close tightly and lock.

E. Adjust visible window components and screens to be neat, square, and plumb, including drain hole covers.

F. Touch up any damage to frame finish with manufacturer’s touch-up paint.

End of Section

Section 08 62 50

DUCTED SKYLIGHTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roof mounted daylighting device, consisting of roof dome, reflective duct, and diffuser assembly; configuration as indicated on the drawings.

1.2 RELATED SECTIONS

A. Section 07 92 00 - Joint Sealants.

B. Section 09 25 00 – Gypsum Drywall.

C. Section 13 34 19 - Metal Building Systems

1.3 REFERENCES

A. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2008a.

C. ASTM A 463/A 463M - Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process; 2006.

D. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process; 2007.

E. ASTM E 283 - Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004.

F. ASTM E 308 - Standard Practice for Computing the Colors of Objects by Using the CIE System; 2006.

G. ASTM E 330 - Structural Performance of Exterior Windows, Curtain Walls and Doors; 2002.

H. ASTM E 547 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain walls by Cyclic Air Pressure Difference; 2000.

I. ASTM E 1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.

J. ASTM E 1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricane.

K. ASTM D 635 - Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position; 2006.

L. ASTM D-1929 - Test Method for Ignition Properties of Plastics; 1996 (2001).

M. UL 181 - Factory Made Air Ducts and Air Connectors.

N. ICC AC-16 - Acceptance Criteria for Plastic Skylights; 2008.

1.4 PERFORMANCE REQUIREMENTS

A. Completed ducted skylight assemblies shall be capable of meeting the following performance requirements:
   1. Air Infiltration Test: Air infiltration will not exceed 0.30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E 283.
   2. Water Resistance Test: No uncontrolled water leakage at 10.5 psf pressure differential with water rate of 5 gallons/hour/sf when tested in accordance with ASTM E 547.
   3. Uniform Load Test:
      a. No breakage, permanent damage to fasteners, hardware parts, or damage to make system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 150 psf (7.18 kPa) or Negative Load of 60 psf (2.87 kPa) in accordance with ICC AC-16 Section A, or Negative Load of 70 psf (3.35 kPA) if tested per ICC AC-16 Section B.
      b. All units shall be tested with a safety factor of (3) for positive pressure and (2) for negative pressure, acting normal to plane of roof in accordance with ASTM E 330.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings. Submit shop drawings showing layout, profiles and product components, including anchorage, flashings and accessories.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engaged in manufacture of ducted skylighting devices for minimum 15 years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

A. Skylighting Device: Manufacturer's standard warranty for 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Solatube International, Inc.; 2210 Oak Ridge Way, Vista, CA 92081. ASD. Tel. Toll Free: 888-765-2882. Tel:

(760) 477-1120. Fax: (760) 597-4488. Email: commsales@solatube.com. Web: www.solatube.com.

B. Equivalent products of other manufacturers will be acceptable on the basis of submittals per Section 01 33 00. Equivalence must be demonstrated through provision of a lighting layout with photometric data supplied to demonstrate light levels will meet original design intent.

2.2 DUCTED SKYLIGHTING DEVICES

A. Ducted Skylights, General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, with and without ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.

B. Operations Building Ducted Skylights: SolaMaster Series: Solatube Model 330 DS Closed Ceiling, 21 inch (530 mm) Daylighting System:
   1. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
      a. Outer Dome Glazing: Glazing: Type DA, 0.143 inch (3.7 mm) minimum thickness injection molded acrylic classified as CC2 material; UV inhibiting, impact modified acrylic blend.
      b. Raybender 3000: Variable prism optic molded into outer dome to
      capture low angle sunlight and limit high angle sunlight.
      c. LightTracker Reflector: Aluminum sheet, thickness 0.015 inch (0.4 mm) with Spectralight Infinity. Positioned in dome to capture low angle sunlight.
   2. Flashing Base: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube.
      a. Base Material: Sheet steel, corrosion resistant, meeting ASTM A 653/A 653M or ASTM A 463/A 463M, 0.028 inch (0.7 mm) thick.
      b. Base Pitched: Pitched Type FP, 22.5 degrees slope from horizontal, 4 inches (102 mm) high.
      c. Base Style: Metal roof flashing without curb, centered on standing seam.
   3. Roof Flashing Turret Extensions: Provide manufacturer's standard extensions where applications require:
   4. Tube Ring: Attached to top of base section; 0.090 inch (2.3 mm) nominal thickness injection molded high impact acrylic; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.

5. Reflective Extension Tube: Aluminum sheet, thickness 0.015 inch (0.4 mm).
    a. Interior Finish: High reflectance specular finish on exposed reflective surface. Visible spectrum (400 nm to 760 nm) greater than 99 percent. Total solar spectrum (400 nm to 2500 nm) less than 80.2 percent.
    b. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.
    c. Tube Diameter: Approximately 21 inches (356 mm).
    d. Provide extension lengths and angles as required to achieve the configurations shown in the Drawings.
6. Reflective 30 degree Adjustable tube: Aluminum sheet, thickness .015 inch (0.4 mm)
    a. Interior Finish: Spectralight Infinity high reflectance specular finish on exposed reflective surface. Visible spectrum (400 nm to 760 nm) greater than 99 percent. Total solar spectrum (400 nm to 2500 nm)
7. Ceiling Ring: Injection molded impact resistant acrylic. Nominal thickness is 0.110 inches (2.8 mm).
8. Dual Glazed Diffuser Assembly:
    a. Upper glazing: PET GAG plastic with EPDM low density sponge seal to minimize condensation and bug, dirt, and air infiltration per ASTM E283. The nominal thickness is 0.039 inches (0.99 mm).
        1) Natural Effect Lens: Type LN.
    b. Lower glazing (Optiview Fresnel Lens): Molded polycarbonate plastic classified as CC1 material. The nominal thickness is 0.022 inches (0.61 mm).
    c. Diffuser Trim Ring: Injection molded acrylic.
        1) Stainless-tone Trim (Optiview Fresnel Lens): Type L5.

C. Maintenance Building Ducted Skylights: SolaMaster Series: Solatube Model 750 DS Open Ceiling, 21 inch (530 mm) Daylighting System:
1. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
    a. Outer Dome Glazing: Glazing: Type DA, 0.143 inch (3.7 mm) minimum thickness injection molded acrylic classified as CC2 material; UV inhibiting, impact modified acrylic blend.
    Raybender 3000: Variable prism optic molded into outer dome to capture low angle sunlight and limit high angle sunlight.
    b. LightTracker Reflector: Aluminum sheet, thickness 0.015 inch (0.4 mm) with Spectralight Infinity. Positioned in dome to capture low angle sunlight.

2. Flashing Base: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube.
    a. Base Material: Sheet steel, corrosion resistant, meeting ASTM A 653/A 653M or ASTM A 463/A 463M, 0.028 inch (0.7 mm) thick.
    b. Base Pitched: Pitched Type FP, 22.5 degrees slope from horizontal, 4 inches (102 mm) high.
    c. Base Style: Metal roof flashing without curb, centered on standing seam.
3. Roof Flashing Turret Extensions: Provide manufacturer's standard extensions where applications require:
4. Tube Ring: Attached to top of base section; 0.090 inch (2.3 mm) nominal thickness injection molded high impact acrylic; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.
5. Reflective Extension Tube: Aluminum sheet, thickness 0.015 inch (0.4 mm).
    a. Interior Finish: High reflectance specular finish on exposed reflective surface. Visible spectrum (400 nm to 760 nm) greater than 99 percent. Total solar spectrum (400 nm to 2500 nm) less than 80.2 percent.
    b. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.
    c. Tube Diameter: Approximately 21 inches (356 mm).
    d. Provide extension lengths and angles as required to achieve the configurations shown in the Drawings.
6. Reflective 30 degree Adjustable tube: Aluminum sheet, thickness .015 inch (0.4 mm)
    a. Interior Finish: Spectralight Infinity high reflectance specular finish on exposed reflective surface. Visible spectrum (400 nm to 760 nm) greater than 99 percent. Total solar spectrum (400 nm to 2500 nm)
7. Diffuser Assembly:
    a. Tube Mounted Lens: Type L1, OptiView fresnel lens, type CC2, visible light transmission >90%.

2.3 ACCESSORIES

A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.

B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.

C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Owner, Architect, or Contractor, or their designated representative. Correct if needed before proceeding with installation of subsequent units.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

End of Section

Section 08 70 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Hardware for interior and exterior doors.

B. Weatherstripping and thresholds at door frames.

1.02 RELATED WORK

A. Section 08 10 00 - Metal Doors and Frames.

B. Section 08 15 40 - Fiberglass Doors and Frames.

C. Section 08 40 00 - Storefront System.

D. Section 26 50 00 - Common Work Results For Electrical.

1.03 REFERENCES

A. ANSI A117.1, CAC Title 24, U.S. Dept. of Justice 28 CFR Part 36 (ADA) - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.

B. AWI - Architectural Woodwork Institute.

C. BHMA - Builders' Hardware Manufacturers Association.

D. DHI - Door and Hardware Institute.

E. NFPA 101 - Life Safety Code.

F. Underwriters Laboratories Inc.

1.04 COORDINATION

A. Coordinate work of this Section with other directly affected Sections involving manufacturer of any internal reinforcement for door hardware.

B. Coordinate keying requirements with Owner's representative as described below.

C. Coordinate connection of all electric hardware control and alarm wiring with building power wiring provided by electrical contractor.

1.05 QUALITY ASSURANCE

A. Design Criteria: The intent of this Section is the provision of all required items of finish hardware. Any work less than this intent shall form the basis for corrective measures under the Contractor's guarantee of all work.

B. Hardware Supplier: Company specializing in supplying commercial and institutional door hardware with minimum three (3) years' experience.

1.06 SUBMITTALS

A. Submit schedule, shop drawings, and product data under provisions of Section 01 33 00.

B. Indicate locations, mounting heights, finishes, accessories, and anchorage of each type of hardware.

C. Provide product data on specified hardware, including explanation of all abbreviations, symbols, and codes used to identify components or functions.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 70 00.

B. Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site, store and protect under provisions of Section 01 60 00.

B. Deliver keys to Owner by secure shipment direct from hardware supplier.

1.09 WARRANTY

A. Provide minimum two year warranty on all locksets, latchsets, and closers under provisions of Section 01 70 00.

1.10 MAINTENANCE MATERIALS

A. Provide special wrenches and tools applicable to each different or special hardware component.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Hinges and Miscellaneous Hardware: Hager (HAG).

B. Latchsets, Locksets, and Cylinders: Schlage (SCH).

C. Stops, Holders and Miscellaneous Hardware: Ives (IVE).

D. Closers: LCN (LCN).

E. Weatherstripping, Thresholds, and Door Bottoms: Pemko (PEM).

F. Panic Exit Hardware: Von Duprin (VON).

G. Storefront Entrance Hardware: Kawneer (KAW).

H. Electric Functions: Schlage (SCH), Security Technologies (SEC), Honeywell (HON).

J. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 OTHER MATERIALS

A. Provide all mounting hardware, plates, trims, accessories, attachments, relays, actuators, and power connections as required for a complete and operable installation.

2.03 KEYING

A. Keying shall be carefully coordinated with Owner's representative, using at least three master levels.

B. Supply 2 keys for each lock, plus 2 keys for each level of master keying; stamp all keys "Do Not Duplicate".

C. Use temporary cores for construction keying; convert to permanent cores in response to Owner's written instructions.

D. Cylinders shall be keyed at the factory of the lock manufacturer where permanent records are maintained.

2.04 FINISHES

A. Finishes are listed in the Hardware Schedule, below.

B. Where not otherwise described, metal finishes shall be either satin stainless steel, satin chrome, or brushed chrome.

2.05 MATERIALS

A. Materials shall be as identified in the Hardware Schedule, below. Hardware Groups are called out in the Door Schedule on the Drawings.

B. Additional or accessory products as required to provide a complete and functional installation shall be compatible with the above materials and are subject to the Architect's approval.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that doors and frames are ready to receive work and dimensions are as indicated on approved shop drawings.

B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions.

B. Use the templates provided by hardware item manufacturer.

C. Mounting heights for hardware from finished floor to center line of hardware item shall be the same as adjacent, existing hardware of the same type, or as indicated on the drawings.

D. Conform to the California Building Code (Section 1133B.2.5.2) for positioning requirements for the disabled.

E. Install transformers, relays and actuators, make electrical connections, and install low-voltage wiring to the point of connection with building power as required for electrical hardware control and alarm systems, carefully following manufacturer's recommendations.

F. Coordinate installation timing with Owner's Representative in a fashion that does not leave building unlocked.

G. Adjust interior and exterior door closers to require a maximum pressure of 5 pounds to push or pull the door open.

3.03 CLEANUP

A. After installation remove all plastic sheets, manufacturer's temporary markings, and construction dirt or markings from finish hardware.

B. Use only cleaners compatible with hardware finish.

3.04 DOOR HARDWARE SCHEDULE

GROUP 1: EXTERIOR STOREFRONT SECURE ENTRY/EXIT
(DOORS 95-101A, 95-105A, 95-112A)
Hinges: 1.5 pair offset pivots (Kawneer)
Exit Device: concealed vertical rod (Von Duprin 3347)
Cylinder: keyed per City standards (Schlage)
Closer: overhead concealed (Kawneer)
Pull: offset tubular (Kawneer)
Seals: compression insert, head and jambs (Kawneer)
Door Bottom: brush sweep (Kawneer)
Threshold: full width aluminum saddle (Kawneer)

GROUP 2: INTERIOR STOREFRONT PASSAGE
(DOOR 95-102A)
Hinges: 1.5 pair offset pivots (Kawneer)
Cylinder: keyed per City standards (Schlage)
Closer: overhead concealed (Kawneer)
Push/Pull: offset tubular (Kawneer)
Seals: compression insert, head and jambs (Kawneer)

GROUP 3: EXTERIOR STOREFRONT SECURE EXIT PAIR
(DOOR 95-103A)
Hinges: 3 pair offset pivots (Kawneer)
Exit Devices: 2 concealed vertical rod (Von Duprin 3347)

Cylinder: keyed per City standards (Schlage)
Closers: 2 overhead concealed (Kawneer)
Pull: offset tubular (Kawneer)
Seals: compression insert, head and jambs (Kawneer)
Door Bottoms: brush sweep (Kawneer)
Threshold: full width aluminum saddle (Kawneer)

GROUP 4: INTERIOR SECURE PASSAGE
(DOOR 95-103B)
Hinges: 1.5 pair 4-1/2" x 4-1/2" (Hager BB1279)
Lockset: Classroom function (Schlage ND70PD)
Closer: surface head mounted (LCN 4110)
Seals: silicone, head and jamb (Pemko S88)
Stop: dome floor stop (Ives FS439)

GROUP 5: INTERIOR STORAGE PAIR
(DOOR 95-104A)
HInges: 3 pair 4-1/2" x 4-1/2" (Hager 1279)
Lockset: Storeroom function (Schlage ND80PD)
Dummy Trim: Single matching dummy lever (Schlage AL170)
Flush Bolts: Manual bolts top & bottom, inactive leaf (Ives FB358)

GROUP 6: INTERIOR SECURE UTILITY
(DOORS 95-106A, 95-107A)
Hinges: 1.5 pair 4-1/2" x 4-1/2" (Hager BB1279)
Locksets: Storeroom function (Schlage ND80PD)
Closers: surface head mounted (LCN 4110)
Seals: silicone, head and jamb (Pemko S88)
Stops: wall bumpers (Ives WS402)
Door Bottom (95-107A only): fixed door shoe, vinyl sweep (Pemko 217AV)

GROUP 7: INTERIOR RESTROOM PASSAGE
(DOORS 95-108A, 95-111A)
Hinges: 1.5 pair ball bearing (Hager 1279)
Closers: surface head mounted (LCN 4110)
Push Plates: 6" x 16" rectangular (Ives 8200/6X16)
Pulls, Plates: 6" x 16" rectangular, 10" pull (Ives 8305-0/6X16)
Mop Plates: 12" x door width, inside surface (Ives 8400)
Seals: adhered vinyl, head and jambs (Pemko S88)
Stop: wall bumper (Ives WS402)

GROUP 8: INTERIOR RESTROOM PRIVACY
(DOORS 95-109A, 96-102A)
Hinges: 3 ball bearing (Hager 1279)
Lockset: privacy function (Schlage ND40S)
Closer: inside surface mount (LCN 4110)
Mop Plate: 10" x full width, inside surface (Ives 8400)
Seals: adhered vinyl, head and jambs (Pemko S88)
Stop: wall bumper (Ives WS402)

GROUP 9: INTERIOR PASSAGE
(DOORS 95-110A, 95-110B, 96-104A, 50-102B)
Hinges: 1.5 pair ball bearing (Hager 1279)
Lockset: classroom security function (Schlage ND75PD)
Seals: adhered vinyl, head and jambs (Pemko S88)
Stop: wall bumper (Ives WS402)

GROUP 10: INTERIOR PRIVACY
(DOOR 95-113A)
Hinges: 1.5 pair ball bearing (Hager 1279)
Lockset: privacy function (Schlage ND40S)
Closer: inside surface mount (LCN 4110)
Seals: adhered vinyl, head and jambs (Pemko S88)
Stop: wall bumper (Ives WS402)

GROUP 11: INTERIOR SECURE STOREFRONT PASSAGE
(DOOR 95-114A)
Hinges: 1.5 pair offset pivots (Kawneer)
Exit Device: concealed vertical rod (Von Duprin 3347)
Cylinder: keyed per City standards (Schlage)
Closer: overhead concealed (Kawneer)
Pull: offset tubular (Kawneer)
Seals: compression insert, head and jambs (Kawneer)

GROUP 12: INTERIOR OFFICE PRIVACY
(DOORS 95-117A - 95-121A)
Hinges: 1.5 pair ball bearing (Hager BB1279)
Lockset: entrance/office function (Schlage ND50PD)
Seals: adhered vinyl, head and jambs (Pemko S88)
Stop: wall bumper (Ives WS402)

GROUP 13: EXTERIOR SECURE UTILITY

(DOORS 95-122A, 95-123A, 16-101A, 16-102A, 80-101B)

Hinges: 1.5 pair ball bearing (Hager BB1279)

Locksets: storeroom function (Schlage ND80PD)

Seals: adhered vinyl, head and jambs (Pemko S88)

Door Bottoms: fixed door shoe, vinyl sweep (Pemko 217AV)

Thresholds: offset saddle (Pemko 158A)

GROUP 14: EXTERIOR SECURE ENTRY/EXIT

(DOORS 96-101A, 96-101E, 96-104A)

Hinges: 1.5 pair ball bearing (Hager BB1279)

Locksets: entrance lock function (Schlage ND53PD)

Seals: adhered vinyl, head and jambs (Pemko S88)

Door Bottoms: fixed door shoe, vinyl sweep (Pemko 217AV)

Thresholds: offset saddle (Pemko 158A)

GROUP 15: INTERIOR PASSAGE PAIR

(DOOR 96-103A)

HInges: 3 pair 4-1/2" x 4-1/2" (Hager 1279)

Lockset: entrance/office function (Schlage ND50PD)

Dummy Trim: Single matching dummy lever (Schlage AL170)

Flush Bolts: Manual bolts top & bottom, inactive leaf (Ives FB358)

Seals: adhered vinyl, head and jambs (Pemko S88)

GROUP 16: EXTERIOR SECURE UTILITY PAIR

(DOORS 96-106A, 50-101B - 50-101F, 50-102A, 80-101A)

Hinges: 3 pair (Hager 1279)

Deadlocks: active leaf; 2-point with City compatible cylinder (Adams Rite 1837)

Deadlatches: active leaf; heavy duty (Adams Rite 4920AN)

Deadlatch Handles: active leaf; Eurostyle handles (Adams Rite 4568)

Flush Bolts: inactive leaf; 2-point with compatible cylinder (Adams Rite 1880)

Seals: adhered vinyl, head and jambs (Pemko S88)

Door Bottoms: fixed door shoe, vinyl sweep (Pemko 217AV)

Thresholds: offset saddle (Pemko 158A)

End of Section

Section 08 80 00

GLASS AND GLAZING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Glass and glazing for doors, windows and storefront systems.

1.02 RELATED WORK

A. Section 08 10 00 - Metal Doors and Frames.

B. Section 08 15 40 - Fiberglass Doors and Frames.

C. Section 08 40 00 - Storefront System.

D. Section 08 51 13 - Metal Windows.

1.03 REFERENCES

A. ANSI Z97.1 - Safety Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings.

B. "Manual of Glazing" of the Flat Glass Marketing Association.

C. U.S. General Service Administration Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings.

D. ASTM Z97.1 Test for Safety Glazing Materials Used in Buildings.

1.04 QUALITY ASSURANCE

A. All glass shall bear the label of its manufacturer and quality.

B. Conform to Flat Glass Marketing Association (FGMA) recommendations for glazing installation methods.

1.05 SUBMITTALS

A. Submit product data under provisions of Section 01 33 00.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Deliver products to site and store on solid blocking, protected from damage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - GLASS PRODUCTS

A. Glass: Vitro, Oldcastle

B. Alternate products may be approved based on submittals made under provisions of Section 01 33 00.

2.02 NON-TEMPERED GLASS - EXTERIOR

A. Glass at Exterior Fixed Storefront, Operable Windows, and Entry Doors: Dual pane, clear, low E, regular strength insulating glass, 1/8” or 3/16” as required to comply with CBC wind loading criteria; Vitro Solarban 60, or equivalent. Solar Heat Gain Coefficient 0.27 or better; U factor 0.27 or better.

2.03 TEMPERED GLASS - EXTERIOR

A. Glass at Exterior Fixed Storefront, Operable Windows, and Entry Doors: Dual pane, clear, tempered safety insulating glass, 1/4”, where required by CBC 2406.4; Vitro Solarban 60, tempered, or equivalent. Solar Heat Gain Coefficient 0.27 or better; U factor 0.27 or better.

2.04 TEMPERED GLASS - INTERIOR

A. Glass at Interior Doors: Single pane 1/4” tempered, clear.

2.05 GLAZING COMPOUNDS

A. Glazing compound may be any Class A, single component compound intended for the specified application.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify surfaces of glazing channels or recesses are clean, free of obstructions, and ready for work of this Section.

B. Beginning of installation means acceptance of substrate.

3.02 INSTALLATION

A. Install glass panels resting on setting blocks. Install applied stop and place spacer shims at 1/4 inch below sightline.

B. Locate and secure using glaziers' clips.

C. Fill gaps between panel and stops with glazing compound until flush with sightline. Tool surface to straight line.

D. Glazing with glazing tape is an acceptable alternate installation.

E. At openings provided with manufacturer's glazing bead, install bead per manufacturer's recommendations, using glazing compound or sealant only as specifically directed.

F. Carefully coordinate glazing installation with bullet resistant film installation.

3.03 CLEANING

A. After installation, mark vision glass with an "X" by using plastic tape or removable paste.

B. Remove glazing materials from finish surfaces.

C. Adjust operable lites to open smoothly and close securely.

D. Remove labels and clean glass after work is completed.

End of Section

Section 08 90 00

LOUVERS AND VENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of stationary type weather louvers. Combination louver/dampers, control dampers, fire dampers, adjustable louvers, penthouses, and smoke vents are covered in other sections.

1-2. GENERAL. Louvers shall be furnished and installed as specified herein and in accordance with the details, louver schedule, or arrangements indicated on the Drawings.

Louvers shall be of the sizes required for opening sizes indicated on the Drawings. Actual opening sizes for louvers scheduled for insertion within existing construction shall be field verified. Actual louver sizes shall allow for shim and caulk space.

1-3. SUBMITTALS. Complete specifications and detailed drawings covering arrangement, dimensions, hardware, accessories, and details of construction and installation of the louvers shall be submitted in accordance with the Submittals Procedures section.

1-4. COLOR SELECTION. Colors of louvers will be selected from the manufacturer's full line of colors by Architect. Procedures for submitting color samples shall be as indicated in the Submittals Procedures section.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damages of any kind. Damaged materials shall be promptly replaced. Materials shall be stored off the ground and protected from the weather.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN CRITERIA.

2-1.01. Governing Standard. Except as modified or supplemented herein, all stationary louvers shall be certified to meet the performance criteria specified and outlined by AMCA Standard 500.

2-1.02. Finishes. Louvers shall have a Kynar paint finish.

70% Kynar paint finishes shall meet the AAMA specification 2605-11 with 1.2 mils [30 µm] total dry film thickness. 50**%** Kynar paint finishes shall meet the AAMA specification 2604-05 with 1.2 mils.

2-1.03. Construction. Louvers shall be of aluminum construction and shall be the product of one manufacturer. Louvers shall be furnished complete with all hardware and appurtenances necessary for a satisfactory installation. Louver sills and flashings shall be as shown on the Drawings. The louvers shall be welded construction.

Stationary type weather louvers shall be architectural style continuous blades with concealed mullions.

2-1.04. Performance Requirements.

2-1.04.01. Stationary Type. The velocity at which the beginning point of water penetration occurs for stationary type weather louvers shall be at least 790 fpm [241 mpm]. The minimum free area for a 48 inches x 48 inches [1220 mm x 1220 mm] louver shall be 54 percent. The maximum static pressure loss at 600 fpm [183 mpm] shall be 0.08 inches [2.0 mm] wc.

2-1.04.02. Acoustical Type. (Not used).

2-2. ACCEPTABLE PRODUCTS.

2-2.01. Stationary Type Weather Louvers. Subject to the requirements specified herein, stationary type weather louvers shall be equivalent to the following:

Ruskin "ELF-375XH”

Arrow United Industries "EA-410”

Alternate products may be used if approved on the basis of submittals made under Section 01 33 00.

2-2.02. Adjustable Type Weather Louvers. Subject to the requirements specified herein, adjustable type weather louvers shall be equivalent to the following:

Ruskin “SLM6375DX”

Arrow United Indutries “EA-450-D”

Alternate products may be used if approved on the basis of submittals made under Section 01 33 00.2-2.03. Brick Vents (Not used).

2-2.04. Accessories.

Stationary and adjustable louvers shall have aluminum removable bird and insect screens.

Adjustable louvers shall have Belimo or approved equivalent electric actuators and all necessary control wiring, switching, and related accessories as required for remote actuation.

2-3. MATERIALS.

Aluminum Extrusions	ASTM B221, Alloy 6063-T5, minimum 0.125 inch [32 mm] thick.
Bird Screen	0.051 inch [1.3 mm] expanded, 0.50 inch flattened bird screen.

PART 3 - EXECUTION

3-1. GENERAL. Products shall be installed in accordance with this section, the manufacturer's instructions, and as indicated on the Drawings.

Complete specifications and detailed drawings covering arrangement, dimensions, hardware, accessories, and details of construction and installation of the louvers and vents will be made available to the louver and vent installer.

3-2. INSTALLATION. The louvers shall be installed with anchors suitable for the adjacent material and shall be caulked as specified in the caulking section. When required, bird screens or insect screens shall be installed on the louvers.

Where aluminum work is to be attached to steel supporting members or other dissimilar metal, the aluminum shall be kept from direct contact with such metals by a heavy coat of epoxy enamel in accordance with the Architectural Painting

section. Aluminum surfaces which will be in contact with concrete or masonry when installed shall be given a heavy coat of epoxy enamel. All paint shall be dry and hard when the coated parts are installed.

End of Section

Section 09 25 00

GYPSUM DRYWALL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Standard and moisture resistant gypsum drywall at walls and ceilings.

B. Gypsum drywall trims and finishing.

1.02 RELATED WORK

A. Section 05 40 00 - Cold Formed Metal Framing.

B. Section 09 90 00 - Paints and Coatings.

1.03 REFERENCES

A. Gypsum Association GA 216 Application and Finishing of Gypsum Board, current edition.

B. ASTM C1396, current edition; Standard Specification for Gypsum Board.

C. ASTM C475, current edition; Standard Specification for Joint Compound, Joint Tape.

D. ASTM C840, current edition; Standard Specification for Application and Finishing of Gypsum Board.

E. ASTM C1002, current edition; Standard Specification for Steel Self Piercing Screws for the Application of Gypsum Panel Products to Wood or Steel Studs.

F. ASTM C1047, current edition; Standard Specification for Gypsum Wallboard.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 01 33 00.

B. Apply a minimum 48" x 48" sample demonstrating the proposed gypsum board finish texture, for approval prior to texturing the remainder of the work.

1.05 QUALITY CONTROL

A. Products shall be single-sourced; obtain each type of gypsum board, trim, and related materials from a single manufacturer.

1.06 DELIVERY, HANDLING, AND STORAGE

A. Deliver, handle, and store materials per manufacturer's published recommendations.

B. Replace damaged materials at no cost to the Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. United States Gypsum Company.

B. Gold Bond Products.

C. CertainTeed Corporation.

D. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 GYPSUM DRYWALL PANELS - WALLS AND CEILINGS

A. Product Description - Fire Barrier Walls and Ceilings: (whether or not noted as "Type X" in the Drawings) USG Firecode "C", Firecode "X", or approved equivalent panels, in thickness indicated in the details or referenced assemblies.

B. Product Description - Moisture Resistant Walls: USG "Sheetrock" Mold Tough or approved equivalent panels where panels will experience regular exposure to moisture, including but not limited to walls behind tub/showers, within 4 feet horizontally of tub/showers, and plumbing walls in common restrooms and laundries.

C. Product Description - Moisture and Abuse Resistant Walls: USG "Sheetrock" Mold Tough AR or approved equivalent panels where panels will experience regular exposure to moisture and impact, including outside of RO/UV Building Electrical Room as shown on Drawings.

D. Product Description - Other Locations: USG "Sheetrock" brand gypsum panels, or approved equivalent, 5/8 inch.

2.03 FASTENERS

A. All fasteners shall be of the length and pattern recommended by the manufacturer of the gypsum panels used, required by the rated system, and as indicated on Drawings.

2.04 METAL CORNERBEAD AND TRIM

A. All metal corner bead, casing bead, and trim, and all accessory items, shall be a system recommended by the manufacturer as compatible with the gypsum panels. Outside corners shall be square unless otherwise noted. Edge shape is square.

2.05 JOINT SYSTEM

A. The joint system, including tape and compounds, shall be a system recommended by the manufacturer as compatible with the gypsum panels used in the Work.

B. Only non-shrinking joint compounds are allowed.

2.06 FINISHING SYSTEMS

A. Preparation Coating: USG "First Coat" high solids drywall primer/sealer or approved equivalent.

B. Interior Walls and Ceilings: USG “Sheetrock” brand Joint Compound or approved equivalent, specific product selected for substrate conditions, to be painted.

2.07 OTHER MATERIALS

A. All other materials, not specifically described but required for a complete and proper installation of gypsum drywall and compliance with rated assembly criteria, shall be as selected by the Contractor subject to approval by the Architect.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that wall and ceiling surfaces are ready to accept the work of this section in compliance with the reference standards.

B. Bring any conditions of uneven framing or inadequate backing, blocking, or support to the immediate attention of the Contractor and Framing Subcontractor. Do not proceed in areas of deficient framing until all corrections have been made.

C. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Deliver and stock gypsum wallboard as directed by the Contractor.
   1. Provide all cranes, lifts, trucks or other means required to stock areas of Work.
   2. Stock gypsum panels 18" minimum from walls to accommodate other trades.

B. General installation standards.
   1. Install per ASTM C840, GA 216 and USG 923 and 927.
   2. Place metal corner bead at all exterior corners.
   3. Use "L" casing bead where indicated on Drawings and wherever gypsum panels abut rather than overlap dissimilar materials; hold molding back 1/8 inch from adjacent surface for sealant.
   4. Tape, fill and sand joints to achieve a smooth, even surface, with maximum camber at edges of 1/32 inch.
   5. Apply preparation coating directly to gypsum panels and joint system per manufacturer's recommendations.
   6. Texture panels to receive the specified finish.

3.03 FINISH AND TEXTURES

A. Unless otherwise noted, finish joints and apply texture to gypsum drywall walls and ceilings as follows:
   1. Walls and ceilings in exposed-to-view areas: Level 4 or higher, light sprayed orange peel without sharp detail, high spots sanded before sealing/painting.
   2. Walls and ceilings in mechanical rooms or out of view: Level 1 or higher, tape and corners set in joint compound.

3.04 PRODUCTION INSPECTION

A. Subcontractor must inspect all work performed by his personnel for conformance with construction documents and referenced standards before indicating to the Owner's Representative that the Work is ready for final inspection. Subcontractor may be held responsible for a re-inspection fee to defray the cost of delays caused by work which is incomplete at the time of final inspection.

3.05 CLEAN UP

A. Maintain the premises in a neat and orderly condition at all times. Periodically remove all trash, debris, and waste from the work in order to maintain clear and unobstructed access.

B. In the event of spilling, splashing or overspraying compound onto other surfaces, immediately remove the excess material and all trace of the residue to the approval of the Owner.

End of Section

Section 09 30 00

CERAMIC TILE

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Ceramic wall and base tile at restroom/locker rooms.

B. Ceramic floor tile at showers.

1.02 RELATED WORK

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 09 25 00 - Gypsum Drywall.

1.03 REFERENCES

A. Ceramic Tile: The Installation Handbook, by the Tile Council of North America, Inc.

B. ASTM C150-12 - Portland Cement.

C. ASTM C144 - Aggregate for Masonry Mortar.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 01 33 00.

B. Submit tile and grout samples under provisions of Section 01 33 00.

1.05 MAINTENANCE DATA

A. Provide maintenance data with closeout documentation.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air to a minimum 50 degrees F prior to, during, and 48 hours after completion of work.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Dal Tile.

B. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 GLAZED TILE AT RESTROOM/LOCKER ROOM WALLS

A. Product: Dal Tile Color Wheel Linear.

B. Size: 4-1/4"" X 8-9/16".

C. Color: One field as selected by Architect.

D. Trim: Bullnose and quarter round as appropriate at edges of field.

E. Grout: Natural grey latex/Portland cement, by Custom Products or equivalent.

2.03 GLAZED TILE AT RESTROOM/LOCKER ROOM WALL BASE

A. Product: Dal Tile Color Wheel Classic.

B. Size: 4-1/4" X 4-1/4".

C. Color: One color as selected by Architect.

D. Trim: Bullnose and quarter round as appropriate at edges of field.

E. Grout: As selected by Architect, by Custom Products or equivalent.

2.04 GLAZED TILE AT SHOWER FLOORS

A. Product: Dal Tile Keystones.

B. Size: 2" X 2".

C. Color: One color as selected by Architect.

D. Grout: As selected by Architect, by Custom Products or equivalent.

2.05 MORTAR MATERIALS – CEMENT MORTAR APPLICATIONS

A. Materials: Portland cement, sand, and lime in a proportion of 1:5:1/2 for horizontal surfaces and 1:7:1 for vertical surfaces.

B. Water: Potable.

C. Reinforcing: 2” x 2” x 16/16 gauge, galvanized, welded wire mesh for floors; and minimum 2.5 pounds per square yard, galvanized, flat, expanded metal lath for walls, or as otherwise approved.

2.06 MORTAR MATERIALS – THIN SET APPLICATIONS

A. Thin-Set Mortar: Master Blend Thin Set Mortar by Custom Building Products.

B. Admixture: Acrylic Mortar Admix by Custom Building Products.

C. Water: Potable.

2.07 MORTAR MATERIALS – MASTIC APPLICATIONS

A. Acrylic Latex Mastic: Acryl 4000 Multi-Purpose Ceramic Tile Mastic by Custom Building Products or approved equivalent.

B. Latex Leveling Compound: Quick-Fix All Purpose Patching Compound by Custom Building Products or approved equivalent.

2.08 ACCESSORIES

A. Grout Sealer: Custom TileLab Grout and Tile Sealer or approved equivalent.

B. Provide such accessories and additional materials as will be required to accomplish a complete and functional tile installation.

PART 3 EXECUTION

3.01 PREPARATION

A. Inspect work area and confirm substrate is ready to receive ceramic tile work.

B. Beginning installation means acceptance of existing substrate conditions.

C. Establish lines, levels, and pattern. Protect from disturbance.

3.02 INSTALLATION

A. Install wall and base tile generally in accordance with recommendations in TCNA reference standard W242 or W243.

B. Install shower tile generally in accordance with recommendations in TCNA reference standard B414, sloping floor 1/4" per foot to drain.

C. Set floor tile in full mortar bed to support tile over full bearing surface, back buttering where appropriate as recommended by mortar manufacturer.

D. Level high spots and fill low spots in wall substrate with leveling compound. Set wall tile in full bed of mastic applied with mastic manufacturer's recommended notched trowel.

E. Maintain uniform joint width.

F. Maximum variation from horizontal plane of unit to adjacent unit: 1/32 inch. Maximum variation of finished planes from flat: 1/8 inch in 10 feet.

G. To accommodate grouting, rake wet mortar out of joints to a depth of 3/16 inch.

H. Fill joints with grout. Pack and work into voids. Neatly tool surface to a finished joint.

I. After grout has dried apply penetrating grout sealer in compliance with manufacturer’s instructions.

3.03 CLEANING

A. Clean soiled surfaces per tile manufacturer's recommendations, using solution which will not harm tile, grout, or adjacent surfaces; use only non-metallic cleaning tools.

B. Remove all waste, debris, and packing materials from work area.

End of Section

Section 09 51 20

SUSPENDED ACOUSTIC TILE CEILING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Suspended metal grid ceiling system at lay-in acoustical tile ceilings.

B. Lay-in acoustical tile panels.

1.02 RELATED WORK

A. Section 09 25 00 - Gypsum Drywall.

B. Section 21 00 00 - Fire Protection System.

C. Division 23 - Heating, Ventilating, and Air Conditioning.

D. Division 26 - Electrical (lighting, alarms).

1.03 REFERENCES

A. ASTM C635-07 - Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

B. ASTM C636-08 - Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.

C. ASTM A653/A653m - Standard Specification for Sheet Steel, Zinc-coated (Galvanized) or Zinc-Iron Alloy-coated (Galvannealed) by the Hot-Dip Process.

D. ASTM C423 - Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

E. ASTM E84 - Surface Burning Characteristics of Building Materials.

F. ASTM E580 - Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint.

G. ASTM E1264 - Classification for Acoustical Ceiling Products.

H. 2010 California Building Code, Section 1613.

I. American Society of Civil Engineers 7-05: Minimum Design Loads for Buildings and Other Structures.

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacture of ceiling suspension system and ceiling tile with three years minimum experience.

B. Installer: Company with three years minimum experience.

1.05 SUBMITTALS

A. Submit product data and samples under provisions of Section 01 33 00.

B. Submit two samples of acoustic tiles with full scale pattern, illustrating material and finish of acoustic units.

C. Submit two samples each, 12 inches long, of suspension system main runner, cross runner, and edge trim.

D. Submit manufacturer's installation instructions under provisions of Section 01 33 00.

1.06 EXTRA STOCK

A. Provide Owner with 10 extra acoustic tile units.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - SUSPENSION SYSTEM

A. Armstrong

B. U. S. Gypsum Company

C. Chicago Metallic Corporation

D. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 SUSPENSION SYSTEM MATERIALS – ACOUSTIC TILE CEILINGS

A. Grid: Prelude XL, intermediate duty 15/16" exposed T system with ESR-1308 seismic evaluation; components die cut and interlocking.

B. Accessories: Stabilizer bars, clips, splices, edge moldings, and other components as required for suspended grid system.

C. Grid Materials: commercial quality cold rolled steel with galvanized coating and bake paint finish.

D. Grid Color: white.

E. Support Channels and Hangers: Galvanized steel; size and type to suit application, to rigidly secure acoustic ceiling system including integral mechanical and electrical components with maximum deflection of 1/360.

2.03 ACCEPTABLE MANUFACTURERS - LAY-IN ACOUSTICAL TILES

A. Armstrong

B. U.S. Gypsum Company

C. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 30 00.

2.04 LAY-IN ACOUSTICAL TILE MATERIALS

A. Tile Characteristics:

1. Product: Armstrong Cirrus
2. Size: 24 x 24 inches
3. Thickness: 3/4 inches
4. Composition: Mineral
5. Acoustics: 0.70 NRC; 35 CAC
6. Edge: Beveled Tegular
7. Surface Color: white
8. Surface Finish: fine texture
9. Recycled Content: 77%
10. Fire Performance: Class A

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that existing conditions are ready to receive work.

B. Verify that layout of hangers will not interfere with other work.

C. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION – SUSPENDED CEILINGS

A. Install system in accordance with manufacturer's instructions and as supplemented in this Section.

B. Install system capable of supporting imposed loads to a deflection of 1/360 maximum.

C. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

D. Supply hangers or inserts for installation as described on the drawings.

E. Hang system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

G. Locate system on room axis according to reflected ceiling plan.

H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

I. Do not eccentrically load system, or produce rotation of runners.

J. Install edge molding at intersection of ceiling and vertical surfaces, using longest practical lengths. Miter corners. Provide edge moldings at junctions with other interruptions. Field rabbett panel or tile edge.

K. Fit acoustic units in place, free from damaged edges or other defects detrimental to appearance and function.

L. Install acoustic units level, in uniform plane, and free from twist, warp and dents.

M. Install hold-down clips to retain panels tight to grid system within 20 ft of an exterior door.

3.03 SEISMIC REQUIREMENTS

A. Install all system components, including intersections, splay bracing, compression struts, splices and perimeter fastenings to meet seismic requirements of CBC 1613 and 1613A.

3.04 TOLERANCES

A. Variation from Flat and Level Surface: 1/8 inch in 10 ft.

B. Variation from Plumb of Grid Members Caused by Eccentric Loads: Two degrees maximum.

3.05 CLEANING AND TOUCH-UP

A. After acoustic tiles are in place, used manufacturer's touch-up paint to repair cut edges as necessary.

B. Clean all fingerprints, smudges, and packaging marks from grid and tiles.

C. Remove all debris and packaging materials from work area.

End of Section

Section 09 90 00

PAINTS AND COATINGS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Surface preparation.

B. Exterior and interior surface finishes.

C. Surface finish schedule.

D. All labor and material necessary for a complete installation of the Work of this Section whether or not specifically described.

1.02 RELATED WORK

A. Section 05 50 00 - Metal Fabrications.

B. Section 08 10 00 - Metal Doors and Frames.

C. Section 09 25 00 - Gypsum Drywall.

1.03 REFERENCES

A. ANSI/ASTM D16-11 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.

1.04 DEFINITIONS

A. Conform to ANSI/ASTM D16 for interpretation of terms used in this Section.

1.05 QUALITY ASSURANCE

A. Product Manufacturer: Company specializing in manufacturing quality paint and finish products with ten years experience.

B. Applicator: Company specializing in commercial painting and finishing with five years documented experience, approved by product manufacturer.

1.06 SUBMITTALS

A. Submit product data under provisions of Section 01 33 00.

B. Provide product data on all finishing products, including full current color selector fans if requested by Architect.

C. Submit under provisions of Section 01 33 00 two samples brushouts 8 x10 inch in size illustrating range of colors and textures specified for each surface finishing product scheduled.

D. Submit manufacturer's application instructions under provisions of Section 01 33 00.

1.07 FIELD SAMPLES

A. Provide samples under provisions of Section 01 33 00.

B. Provide field sample panel, a minimum of 10 square feet of painted surface, illustrating coating color, texture, and finish, for each coating color when requested by the Architect or Owner's representative.

C. Locate where directed.

D. Accepted sample may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labelled containers; inspect to verify acceptance.

B. Container labelling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, 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 well ventilated area, unless required otherwise by manufacturer's instructions.

D. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45 degrees F (7 degrees C) for 24 hours before, during, and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.

B. Do not apply exterior coatings during rain or when relative humidity is above 50 percent, unless required otherwise by manufacturer's instructions.

C. Minimum Application Temperatures for Latex Paints: 45 degrees F (7 degrees C) for interiors; 50 degrees F (10 degrees C) for exterior; unless required otherwise by manufacturer's instructions.

D. Minimum Application Temperature for Varnish Finishes: 65 degrees F (18 degrees C) for interior or exterior, unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 foot candles measured mid-height at substrate surface.

1.10 EXTRA STOCK

A. Provide a one gallon container or 5% of total job amount of each color (whichever is greater) to Owner.

B. Label each container with color, texture, and room locations, in addition to the manufacturer's label.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - PAINT, STAIN, PRIMERS AND SEALERS

A. Dunn Edwards, Sherwin Williams.

B. Alternate products may be used if approved on the basis of submittals made under the provisions of Section 01 33 00.

2.02 MATERIALS

A. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.

B. Stains: Ready mixed partially-penetrating sealer and coating capable of providing a homogenous application filling all voids and surface imperfections.

C. Coating Application Characteristics: Good flow and brushing properties; capable of drying or curing free of streaks or sags.

D. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

2.03 FINISHES

A. Refer to Materials Schedules for surface finish locations; refer to Drawings for color locations.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that substrate conditions are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:

1. Plaster and Gypsum Wallboard: 12 percent.
2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
3. Interior Located Wood: 15 percent,
4. Exterior Located Wood: 19 percent.

D. Beginning of installation means acceptance of existing substrate.

3.02 PREPARATION

A. Remove in place electrical plates, hardware, light fixture trim, and fittings prior to preparing surfaces or finishing.

B. Correct minor defects and clean surfaces which affect work of this Section.

C. Shellac and seal marks which may bleed through surface finishes.

D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

E. Aluminum Surfaces Scheduled for Field Paint Finish: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.

F. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish: Remove foreign particles to permit adhesion of finishing materials. Apply compatible sealer or primer.

G. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.

H. Concrete Floors: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.

I. Copper Surfaces Scheduled for a Paint Finish: Remove contamination by steam, high pressure water, or solvent washing. Apply vinyl etch primer immediately following cleaning.

J. Copper Surfaces Scheduled for a Natural Oxidized Finish: Remove contamination by applying oxidizing solution of copper acetate and ammonium chloride in acetic acid. Rub on repeatedly for required effect. Once attained, rinse surfaces with clear water and allow to dry.

K. Gypsum Board Surfaces: Latex fill minor defects. Spot prime defects after repair.

L. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

M. Concrete and Unit Masonry Surfaces Scheduled to Receive Sealer or Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry. Fill cracks and voids with elastomeric patching material only where opaque painted finish will be applied.

N. Plaster Surfaces: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

O. Uncoated Steel and Iron Surfaces: Remove grease, scale, dirt, and rust. Where heavy coatings of scale are evident, remove by wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution,

ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.

P. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.

Q. Interior Wood Items Scheduled to Receive Paint Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.

R. Interior Millwork and Wood Casework Scheduled to Receive Transparent Finish: Remove handling marks or effects of exposure to moisture with a thorough final sanding over all surfaces of the exposed portions, using at least 150 grit or finer sandpaper, and thoroughly clean all surfaces before applying sealer and finish.

S. Exterior Wood Scheduled to Receive Paint Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied.

T. Wood and Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

U. Previously Painted Surfaces: Thoroughly clean surfaces and repair blemishes. Prepare previously painted surfaces as recommended by the coating manufacturer.

3.03 PROTECTION

A. Protect elements surrounding the work of this Section from damage or disfiguration.

B. Repair damage to other surfaces caused by work of this Section.

C. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.

D. Remove empty paint containers from site.

3.04 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Do not apply finishes to surfaces that are not dry.

C. Apply each coat to uniform finish.

D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.

E. Sand lightly between coats to achieve required finish.

F. Allow applied coat to dry before next coat is applied.

G. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

H. Prime back surfaces of interior and exterior woodwork with primer paint.

I. Prime back surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.

J. Apply first coat of masonry sealer as a mist coat to break surface tension; apply second coat per manufacturer's recommendations, assuring a completely saturated application. Take care to thoroughly seal all sides of horizontal and vertical grout joints.

3.05 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Paint shop primed equipment. Paint shop prefinished items exposed to view in inhabited areas.

B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

C. Prime and paint insulated and exposed-to-view pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports.

D. Replace identification markings on mechanical or electrical equipment when painted accidently.

E. Paint exposed conduit and electrical equipment occurring in finished areas.

F. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment with fire retardant coating as required by utility companies.

G. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.

3.06 CLEANING

A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.

B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.

C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove daily from site.

3.07 MATERIALS SCHEDULE - EXTERIOR SURFACES

A. Galvanized Metal:
   1. Pre-Treatment with Krud Kutter Metal Clean & Etch.
   2. One coat industrial acrylic primer.
   3. Two coats semi-gloss acrylic paint.

B. Ferrous Metal:
   1. One coat industrial direct-to-metal acrylic primer.
   2. Two coats semi-gloss industrial alkyd urethane enamel.

C. Unfinished Wood:
   1. One coat stain-blocking, mildew resistant acrylic primer.
   2. Two coats semi-gloss industrial alkyd urethane enamel.

D. Pre-primed Fiberglass Exterior Doors and Door Frames:
   1. Two coats semi-gloss industrial acrylic paint.

E. Pre-primed Overhead Door Curtains:
   1. Two coats semi-gloss industrial alkyd urethane enamel.

3.08 MATERIALS SCHEDULE - INTERIOR SURFACES

A. Pre-primed, Painted Interior Metal Doors and Frames:
   1. Two coats semi-gloss acrylic paint.

B. Gypsum Board Walls and Ceilings, Restroom/Locker Rooms, Break Room, Laundry/Uniform Room, Sample Room, Janitor Closet, Hall 2:
   1. One coat acrylic primer.
   2. Two coats semi-gloss acrylic paint.

C Gypsum Board Walls and Ceilings, Elsewhere:
   1. One coat acrylic drywall primer.
   2. Two coats eggshell acrylic paint.

D. Miscellaneous Metals:
   1. One coat acrylic primer.
   2. Two coats semi-gloss acrylic paint.

End of Section

Section 09 96 11

PROTECTIVE COATINGS

PART 1 - GENERAL

1-1. SCOPE. This section covers field applied protective coatings, including surface preparation, protection of surfaces, inspection, and other appurtenant work for equipment and surfaces designated to be coated with heavy-duty maintenance coatings. Regardless of the number of coats previously applied, at least two field coats in addition to any shop coats or field prime coats shall be applied to all surfaces unless otherwise specified. Note that some equipment is shop coated and finished per specifications.

1-2. GENERAL. Cleaning, surface preparation, coating application, and thickness shall be as specified herein and shall meet or exceed the coating manufacturer's recommendations. When the manufacturer's minimum recommendations exceed the specified requirements, Design-Builder shall comply with the manufacturer's minimum recommendations. Design-Builder shall comply with this Specification and the coating manufacturer's recommendations.

1-2.01. Governing Standards. All cleaning, surface preparation, coating application, thickness, testing, and coating materials (where available) shall be in accordance with the referenced standards of the following AWWA, ANSI, NACE, SSPC, NSF, and ASTM.

1-2.02. Delivery and Storage. All coating products shall be received and stored in accordance with the coating manufacturer's recommendations.

1-2.03. Coatings, Painting, and Linings Covered in Other Sections.

Architectural painting.

Dampproofing of concrete when NSF compliance is not required.

Corrosion protection lining systems for secondary containment.

Elastomeric high solids urethane lining systems for corrosion protection and waterproofing.

Water repellant for masonry.

Elastomeric deck covering.

Steel tank coating.

1-3. SUBMITTALS. Design-Builder shall submit color cards for all coatings proposed for use to the Owner, together with complete descriptive specifications, manufacturer's product data sheet and the completed Coating System Data Sheets for review and color selection. Each product data sheet shall include application temperature limits including recoat time requirements for the ambient conditions at the site, including temperatures up to 130°F [54°C].

When the proposed products will be required to have ANSI/NSF 61 compliance, Design-Builder shall verify that the proposed systems are in compliance with ANSI/NSF 61.

Coating System Data Sheets (Figures 1-09 96 11 and 2-09 96 11) shall be generated as necessary and shall be assigned a unique number with a prefix letter based on the following:

Prefix	Surfaces	Fig. 09 96 11
A	Iron and steel (coad entirely in field)	1
A	Iron and steel (shop primed)	2
C	Concrete and concrete block	1
E	Equipment - submerged	1
E	Equipment – nonsubmerged	2
F	Nonferrous metal	1
G	Galvanized	1
H	High temperature	1
P	PVC and FRP	1

Each coating system that will be applied entirely in the field shall be assigned only a prefix letter and no suffix letter. Fig.1-09 96 11 shall be submitted for each surface coated entirely in the field.

Each shop-applied coating system that includes one or more field applied coats shall be assigned both a prefix letter and suffix letter “F”. Fig.2-09 96 11shall be submitted for each surface having a shop applied coating and one or more field applied finish coats.

A separate Coating System Data Sheet shall be developed and submitted for each surface scheduled to be coated or variation or change in a coating system. The number identifying the surface and coating system shall be of the form $A1_1$ or $A1_2$-F. The subscript number shall be assigned by the Design-Builder so that each surface and coating system combination is uniquely identified. For example:

$A1_1$-F may be assigned to “Epoxy – one coat to metal curbs for skylights and power roof ventilators that have been shop primed”.

$A2_1$ may be assigned to “Epoxy – two coats to non-galvanized structural and miscellaneous steel exposed to view inside buildings”.

$C2_1$ may be assigned to “Epoxy – two coats to all concrete and concrete block in corrosive area (Except floors and surfaces scheduled to receive other coatings) which are exposed to view”.

$C2_2$ may be assigned to “Epoxy – two coats to walls, floors, and curbed areas, adjacent to corrosive chemical storage and feed equipment as indicated on the Drawings”.

The manufacturer’s standard colors will be acceptable for all coatings.

1-4. QUALITY ASSURANCE.

1-4.01. Coating System Data Sheet Certifications. Not used.

1-4.02. Special Interior Coating Systems. Not used.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS.

2-1.01. Alternative Manufacturers. In addition to the coatings listed herein, equivalent products of other manufacturers that distribute globally will also be acceptable.

2-1.02. Equivalent Coatings. Whenever a coating is specified by the name of a proprietary product or of a particular manufacturer or vendor, it shall be understood as establishing the desired type and quality of coating. Other manufacturers' coatings will be accepted, provided that sufficient information is submitted to enable Design-Builder to determine that the proposed coatings are equivalent to those named. Information on proposed coatings shall be submitted for review in accordance with the Submittals Procedures section.

2-2. MATERIALS. All coatings shall be delivered to the job in original, unopened containers, with labels intact. Coatings shall be stored indoors and shall be protected against freezing. No adulterant, unauthorized thinner, or other material not included in the coating formulation shall be added to the coating for any purpose.

All coatings shall conform to the air quality regulations applicable at the location of use. Coating materials that cannot be guaranteed by the manufacturer to conform, whether or not specified by product designation, shall not be used.

With the exception of heat resistant coatings, the coatings specified have been selected on the basis of the manufacturer's statement that the VOC content of the product is 2.8 lbs per gallon or less; however, it shall be the Coating Supplier's responsibility to supply only coating materials that are in compliance with the requirements of all regulatory agencies. Local regulations may require some coatings to have a lower VOC content than specified herein. The coatings specified may meet the VOC limits in the unthinned (as shipped) condition, but may exceed the limits if thinned according to the manufacturer's recommendations. In such case, the coatings shall not be thinned beyond the 2.8 lbs per gallon limit, and if the product cannot be thinned to suit the application method or temperature limits, another manufacturer's coating shall be used, subject to acceptance by Design-Builder.

Coating Supplier shall be responsible for ensuring the compatibility of field coatings with each other or with any previously applied coatings. Coatings used in successive field coats shall be produced by the same manufacturer. The first field coat over shop coated or previously coated surfaces shall cause no wrinkling, lifting, or other damage to underlying coats.

All coatings used on surfaces that will be in contact with potable or treated water shall be certified as being in compliance with ANSI/NSF 61. Coatings that cannot be so certified, whether or not specified by manufacturer and by product designation, shall not be used.

All intermediate and finish coating materials that will be in contact with wastewater atmosphere shall be guaranteed by the manufacturer to be fumeproof and suitable for wastewater plant atmosphere that contains hydrogen sulfide. Coatings that cannot be so guaranteed shall not be used. Lead-free, chromium-free, and mercury-free coatings shall be used.

2-2.01. Primers.

Universal Primer (tie coat)	PPG Amercoat "Amercoat 385 Epoxy", Carboline "Rustbond", ICI Devoe "Devran 224HS", Tnemec "Series 27 F.C. Typoxy", or Sherwin-Williams "Dura Plate 235".
Zinc Primer	PPG Amercoat "Dimetate 9 Series", Carboline "Carbo Zinc II Series", ICI Devoe "Catha-Coat 304V", or Sherwin-Williams "Zinc Clad II Series".

2-2.02. Fillers and Surfacers.

Epoxy Concrete Block Filler	PPG Amercoat "Amerlock 400BF Epoxy Block Filler", Carboline "Sanitile 600", ICI Devoe "Truglaze 4015", Tnemec "Series 54-562", or Sherwin-Williams "Kem Cati-Coat HS".
Epoxy Concrete Filler and Surfacer	Tnemec "Series 218 MortarClad", PPG Amercoat "NuKlad 114A", Carboline "Carboguard 510", or Sherwin-Williams "Steel Seam FT910".

2-2.03. Intermediate and Finish Coatings.

Epoxy (NSF certified systems)	
Ferrous Metal Surfaces and Concrete Surfaces in Contact with Treated or Raw Water in Potable Water Facilities	PPG Amercoat "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", ICI Devoe "Bar-Rust 233H" Tnemec "Series N140 Pota-Pox Plus", or Sherwin-Williams "Dura Plate 235 NSF"; immersion service.
Epoxy	
Concrete Floors	PPG Amercoat "Amerlock 400", Carboline "Carboguard 890", ICI Devoe "Devran 224HS", Tnemec "Series N69 Hi-Build Epoxoline II", or Sherwin-Williams "Armorseal 1000HS"; nonskid.
Ferrous Metal Surfaces and Masonry or Concrete Surfaces Other Than Floors	PPG Amercoat "Amercoat 385 Epoxy", Carboline "Carboguard 890", ICI Devoe Devran "224HS", Tnemec "Series N69 Hi-Build Epoxoline II", or Sherwin-Williams "Dura Plate 235".
Flake-Filled Epoxy	Carboline "Plasite 4500/4500S", Sherwin-Williams "Sher-Glass FF".

Aliphatic Polyurethane	PPG Amercoat "Amercoat 450H", Carboline "Carbothane 134HG", ICI Devoe "Devthane 379H" Tnemec "Series 1074 Endura-Shield II", or Sherwin-Williams "Acrolon 218HS".
Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Medium Consistency Coal Tar	Carboline "Bitumastic 50" or Tnemec "46-465 H.B. Tnemecol".
Vinyl Ester	Tnemec "Series 120 Vinester" Carboline "Plasite 4110" or Sherwin-Williams "Magnalux 304FF".
Heat-Resistant	Suitable for temperatures up to 400°F [207°C]; PPG Amercoat "Amerlock 400", Carboline "Thermaline 450", Tnemec "43-36 Chrome Aluminum", or Sherwin-Williams "Silver-Brite Aluminum".

PART 3 - EXECUTION

3-1. SURFACE PREPARATION. All surfaces to be coated shall be clean and dry and shall meet the recommendations of the coating manufacturer for surface preparation. Freshly coated surfaces shall be protected from dust and other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss on previously coated surfaces shall be dulled, if necessary, for proper adhesion of topcoats.

Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film, except for concrete block construction where a rough surface is an inherent characteristic.

When applying touchup coating or repairing previously coated surfaces, the surfaces to be coated shall be cleaned as recommended by the coating manufacturer, and the edges of the repaired area shall be feathered by sanding or wire brushing to produce a smooth transition that will not be noticeable after the coating is applied. All coatings made brittle or otherwise damaged by heat of welding shall be completely removed.

3-1.01. Galvanized Surfaces. Galvanized surfaces shall be prepared for coating according to the instructions of the manufacturer of the epoxy. Any chemical treatment of galvanized surfaces shall be followed by thorough rinsing with clean water.

3-1.02. Ferrous Metal Surfaces. Ungalvanized ferrous metal surfaces shall be prepared for coating by using one or more of the following cleaning procedures specified here-in: solvents (SSPC-SP1); abrasive blasting (SSPC-SP5, -SP10, -SP6, or -SP7) power tools (SSPC-SP3 or -SP11); or hand tools (SSPC-SP2). Oil and grease shall be completely removed in accordance with SSPC-SP1 before beginning any other cleaning method. Surfaces of welds shall be scraped and ground as necessary to remove all slag and weld spatter. Tools which produce excessive roughness shall not be used.

All components of equipment that can be properly prepared and coated after installation shall be installed prior to surface preparation. Components that will be inaccessible after installation shall have the surfaces prepared and coated before installation. Motors, drive trains, and bearings shall be protected during surface preparation in accordance with the equipment manufacturer's recommendations.

All cut or sheared edges shall be ground smooth to a 1/8 inch minimum radius for all material 1/4 inch thickness and larger. For material thickness less than 1/4 inch all cut or sheared edges shall be ground smooth to a radius equal to 1/2 the material thickness. Grinding of rolled edges on standard shapes with a minimum radius of the 1/16 inch will not be required.

All ferrous metal surfaces shall have all welds ground smooth and free of all defects in accordance with NACE Standard SP0178, Appendix C, Designation C and sharp edges ground smooth, if not previously prepared in the shop. Instead of blending of the weld with the base metal as required by the NACE standard, it will be acceptable to furnish a welded joint that has a smooth transition of the weld to the base metal. All welds shall be ground smooth to ensure satisfactory adhesion of paint.

The cleaning methods and surface profiles specified herein are minimums, and if the requirements printed in the coating manufacturer's data sheets exceed the limits specified, the value printed on the data sheets shall become the minimum requirement.

3-1.02.01. Ferrous Metal Surfaces – Non-immersion Service. Ferrous metal surfaces, including fabricated equipment, in non-immersion service shall be cleaned to the degree recommended by the coating manufacturer for surfaces to be coated with coal tar epoxy, epoxy, and heat-resistant coatings, except galvanized surfaces. Surface preparation of ferrous metal surfaces in non-immersion service shall consist of abrasive blast cleaning to SSPC-SP6, and the

first application of coating shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Design-Builder. Surface profile shall be as recommended by coating manufacturer, but not less than 2.0 mils.

3-1.02.02. Ferrous Metal Surfaces - Immersion Service. Surface preparation of ferrous metal surfaces in immersion service shall consist of abrasive blast cleaning to at least SSPC-SP10 and the first application of coating shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Design-Builder. Surface profile shall be as recommended by coating manufacturer, but not less than 3.5 mils [88 µm].

3-1.03. Concrete Surfaces. All concrete surfaces shall be free of objectionable substances and shall meet the coating manufacturer's recommendations for surface preparation. Concrete surfaces shall be prepared in accordance with SSPC-SP13/NACE 6. Any other surface preparation recommended by the coating material manufacturer shall be brought to Design-Builder's attention and may be incorporated into the work if acceptable to Design-Builder.

All concrete surfaces shall be dry when coated and free from dirt, dust, sand, mud, oil, grease, and other objectionable substances. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started.

New concrete shall have cured for at least 4 weeks before coating is applied as recommended by the material manufacturer. Concrete surfaces shall be tested for capillary moisture in accordance with ASTM D4263. There shall be no capillary moisture when coatings are applied on concrete.

All surfaces to be coated shall be cleaned in accordance with ASTM D4258 and abraded in accordance with ASTM D4259. Surface profile shall be at least 25 percent of the dry film thickness specified for the coating system. Prior to application of the coating, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. Spalled areas, voids, and cracks shall be repaired in accordance with the Concrete section and as acceptable to the Design-Builder. Fins and other surface projections shall be removed to provide a flush surface before application of coating.

Except where epoxy is applied as damp-proofing, the concrete surfaces, including those with bug holes less than 1 inch in any dimension, shall be prepared as recommended by the manufacturer, using an epoxy concrete filler and surfacer. Where coating with a vinyl ester the concrete filler and surfacer shall be as recommended by the manufacturer to be compatible with vinyl ester.

3-1.04. Concrete Block Surfaces. Voids and openings in concrete block surfaces shall be pointed. All exposed exterior surfaces and surfaces to be coated with epoxy, including the joints, shall be filled so that a continuous unbroken coating film is obtained.

3-1.05. Copper Tubing. All flux residue shall be removed from joints in copper tubing. Immediately before coating is started, tubing shall be wiped with a clean rag soaked in xylol.

3-1.06. Plastic Surfaces. All wax and oil shall be removed from plastic surfaces that are to be coated, including PVC and FRP, by wiping with a solvent compatible with the specified coating.

3-1.07. Hardware. Hardware items such as bolts, screws, washers, springs, and grease fittings need not be cleaned prior to coating if there is no evidence of dirt, corrosion, or foreign material.

3-1.08. Aluminum. When a coating system is required, remove all oil or deleterious substance with neutral detergent or emulsion cleaner or blast lightly with fine abrasive.

3-1.09. Stainless Steel. When a coating system is required, surface preparation shall conform to the coating manufacturer's recommendations.

3-2. MIXING AND THINNING. Coating shall be thoroughly mixed each time any is withdrawn from the container. Coating containers shall be kept tightly closed except while coating is being withdrawn.

Coating shall be factory mixed to proper consistency and viscosity for hot weather application without thinning. Thinning will be permitted only as necessary to obtain recommended coverage at lower application temperatures. In no case shall the wet film thickness of applied coating be reduced, by addition of coating thinner or otherwise, below the thickness recommended by the coating manufacturer. Thinning shall be done in compliance with all applicable air quality regulations.

3-3. APPLICATION. Coating shall be applied in a neat manner that will produce an even film of uniform and proper thickness, with finished surfaces free of runs, sags, ridges, laps, and brush marks. Each coat shall be thoroughly dry and hard before the next coat is applied. Each coat shall be a different color, if available. In no case shall coating be applied at a rate of coverage greater than the maximum rate recommended by the coating manufacturer.

Coating failures will not be accepted and shall be entirely removed down to the substrate and the surface recoated. Failures include but are not limited to sags, checking, cracking, teardrops, fat edges, fisheyes, or delamination.

3-3.01. Priming. Edges, corners, crevices, welds, and bolts shall be given a brush coat (stripe coat) of primer before application of the primer coat. The stripe coat shall be applied by a brush and worked in both directions. Special attention shall be given to filling all crevices with coating. When using zinc primers the stripe coat shall follow the initial prime coat.

Abraded and otherwise damaged portions of shop-applied coating shall be cleaned and recoated as recommended by the manufacturer of the finish coating. Welded seams and other uncoated surfaces, heads and nuts of field-installed bolts, and surfaces where coating has been damaged by heat shall be given a brush coat of the specified primer. Before the specified spot or touchup coating of metal surfaces, edges, corners, crevices, welds, and bolts in the area of the spot or touchup coating shall be given a brush coat of primer. This patch, spot, or touchup coating shall be completed, and the paint film shall be dry and hard, before additional coating is applied.

3-3.02. Epoxy. When used, epoxy shall be applied in accordance with the coating manufacturer's recommendations, including temperature limitations and protection from sunlight until top-coated.

When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

When applying high build epoxy coatings with a roller or brush and where a dry film thickness of at least 4-6 mils per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

3-3.03. Coal Tar Epoxy. When used, the application of coal tar epoxy, including time limits for recoating, shall conform to the recommendations of the coating manufacturer.

When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

3-3.04. Vinyl Ester. When used, the application of vinyl ester coating system, including time limits for recoating and temperature requirements of the materials, shall conform to the recommendations of the coating manufacturer.

3-3.05. Film Thickness. The total coating film thickness including intermediate coats and finish coat, shall be not less than the following:

Type of Coating	Minimum Dry Film Thickness
Medium consistency coal tar	20 mils [500 µm].
Coal tar epoxy (two coats)	20 mils [500 µm].
Epoxy	
Floors (two coats)	10 mils [250 µm].
Surfaces with first coat of epoxy and final coat of aliphatic polyurethane	7 mils [175 µm] (5 mils [125 µm] DFT for epoxy plus 2 mils [50 µm] DFT for aliphatic polyurethane).
Surfaces with first and second coat of epoxy and final coat of aliphatic polyurethane	12 mils [300 µm] (10 mils [250 µm] DFT for epoxy plus 2 mils [50 µm] DFT for aliphatic polyurethane).
Other surfaces (two coats)	10 mils [250 µm].
Immersion service (three coats)	15 mils [375 µm].
Flake-filled epoxy (two coats)	30 mils [750 µm].
Vinyl ester	30 mils [750 µm].
Zinc, epoxy, polyurethane	
Surfaces with first coat of zinc, intermediate coat of epoxy, and final coat of aliphatic polyurethane	10 mils [250 µm], 3 mils [75 µm] zinc, 5 mils [125 µm] epoxy, plus 2 mils [50 µm] for aliphatic polyurethane.
Heat-resistant (silicone)	3 mils [75 µm].
High heat-resistant (silicone)	3 mils [75 µm].
Other (one coat)	5 mils [125 µm].
Other (two coats)	10 mils [250 µm].

3-3.06. Weather Conditions. Coatings shall not be applied, except under shelter, during wet, damp, or foggy weather, or when windblown dust, dirt, debris, or insects will collect on freshly applied coating.

Coatings shall not be applied at temperatures lower than the minimum temperature recommended by the coating manufacturer, or to metal surfaces such as tanks or pipe containing cold water, regardless of the air temperature, when metal conditions are likely to cause condensation. When necessary for proper application, a temporary enclosure shall be erected and kept heated until the coating has fully cured.

Coatings shall not be applied at temperatures higher than the maximum temperature recommended by the coating manufacturer. Where coatings are applied during periods of elevated ambient temperatures, the coatings supplier shall be jointly responsible to ensure that proper application is performed including adherence to all re-coat window requirements. Precautions shall be taken to reduce the temperature of the surface application, especially for metal, at elevated temperatures above 100°F including shading application area from direct sunlight, applying coating in the evening or at night, and ventilating the area to reduce the humidity and temperature.

Vinyl ester coating materials, when required, shall be maintained during transportation, storage, mixing, and application at the temperature required by the coating manufacturer, 35°F to 90°F.

3-4. REPAIRING FACTORY FINISHED SURFACES. Factory finished surfaces damaged prior to acceptance by Owner shall be spot primed and recoated with materials equivalent to the original coatings. If, in the opinion of Design-Builder, spot repair of the damaged area is not satisfactory, the entire surface or item shall be recoated.

3-5. PROTECTION OF SURFACES. Throughout the work coating system subcontractor shall use drop cloths, masking tape, and other suitable measures to protect adjacent surfaces. Coating system subcontractor shall be responsible for correcting and repairing any damage resulting from its operations. Coatings spilled or spattered on adjacent surfaces which are not being coated at the time shall be immediately removed. Exposed concrete or masonry not specified to be coated which is damaged by coatings shall be either removed and rebuilt or, where authorized by Owner, coated with two coats of masonry coating.

3-6. FIELD QUALITY CONTROL. The following inspection and testing shall be performed: surface profile, visual inspection, and wet and dry film thickness testing. All inspection and testing shall be witnessed by Design-Builder.

3-6.01. Surface Profile Testing. The surface profile for ferrous metal surfaces shall be measured for compliance with the specified minimum profile. The surface profile for concrete shall comply with SSPC 13/NACE 6 Table 1 for severe service.

3-6.02. Visual Inspection. The surface of the protective coatings shall be visually inspected.

3.6.03. Film Thickness. Coating film thickness shall be verified by the coating system subcontractor by measuring the film thickness of each coat as it is applied and the dry film thickness of the entire system. Wet film thickness shall be measured with a gauge that will measure the wet film thickness within an accuracy of ±0.5 mil. Dry film thickness shall be measured in accordance with SSPC-PA 2.

3-6.04. Spark Testing. Not required.

3-6.05. Adhesion Testing. Not required.

3-7. FIELD PRIMING SCHEDULE. In general, steel and cast iron surfaces of equipment are specified to be shop primed. Any such surfaces which have not been shop primed shall be field primed. Damaged or failed shop coatings which have been determined unsuitable by Design-Builder shall be removed and the

surfaces shall be field coated, including prime coat (if any). Galvanized, aluminum, stainless steel, and insulated surfaces shall be field primed. Primers used for field priming, unless otherwise required for repair of shop primers, shall be:

Surface To Be Primed	Material
Equipment, surfaces to be coated with	
Aliphatic polyurethane	Universal primer.
Epoxy	Same as finish coats.
Coal tar coating	Same as finish coats.
Vinyl ester	Same as finish coats.
Steel and cast iron, surfaces to be coated with	
Epoxy	Same as finish coats or inorganic zinc.
Coal tar coating	Same as finish coats.
Aluminum	Epoxy.
Galvanized	Epoxy.
Copper	Epoxy.
Stainless steel	Epoxy.
Plastic surfaces, including PVC and FRP	Same as finish coats.
Insulated piping	As recommended by manufacturer of finish coats.
Concrete, surfaces to be coated with epoxy	
For damp-proofing	Epoxy.
For all other surfaces	Epoxy concrete filler and surfacer.
Concrete block exposed in exterior locations	Epoxy concrete block filler.
Concrete block to be coated with epoxy	Epoxy concrete block filler.

Unless otherwise recommended by the coating manufacturer or specified herein, priming will not be required on concrete, or concrete block, nor on metal surfaces specified to be coated with coal tar epoxy, and heat-resistant coatings. Concrete surfaces to be coated with epoxy shall be filled with epoxy concrete filler and surfacer so that a continuous film is obtained, except where concrete is damp-proofed with epoxy.

3-8. FINISH COATING SYSTEMS. The following schedule lists coatings systems and coating surface designations. See Article1-3 for a definition of the surface designations.

No.	Finish Coating Systems	Coating Surface Designation						
		A	C	E	F	G	H	P
1.	Epoxy – One coat	x			x	x		
2.	Epoxy – Two coats	x	x	x	x	x		x
3.	Epoxy / NSF – Two coats		x	x				
4.	Epoxy – Three coats	x	x	x				
5.	Epoxy / NSF – Three coats	x	x	x				
6.	Epoxy – First coat Aliphatic polyurethane – Finish coat	x	x	x	x	x		x
7.	Epoxy – First and second coat Aliphatic polyurethane – Finish coat	x	x	x	x	x		
8.	Universal primer – First coat Aliphatic polyurethane – Finish coat	x		x				
9.	Medium consistency coal tar – Two coats	x	x	x				
10.	Coal tar epoxy – Two coats	x	x	x				
11.	Vinyl ester – Two coats	x	x	x				
12.	Heat resistant – Two coats						x	
13.	High heat resistant – Two coats						x	
14.	Zinc primer – First coat Epoxy – Intermediate coat Aliphatic polyurethane – Final coat	x		x				
15.	Flake-filled epoxy	x		x				

3-8.01. Surfaces Not To Be Coated. Unless otherwise specified, the following surfaces shall be left uncoated:

Exposed aluminum, except ductwork.
Polished or finished stainless steel. Unfinished stainless steel, except flashings and counter flashings, shall be coated.
Nickel or chromium.
Galvanized surfaces, except piping, conduit, ductwork, and other items specifically noted.

Rubber and plastics, except as specified.
Exterior concrete.
FRP wastewater troughs.
Surfaces specified to be factory finished.

3-8.02. Shop Finishing. Items to be shop finished include the following. Shop finishing shall be in accordance with the coating manufacturer's recommendations.

a. All slide gates.
b. All conveyors.
c. Other surfaces where blast cleaning cannot be or is not recommended to be performed in the field.
d. Other items as otherwise specified.

3-8.03. Field Coating. Items to be field coated include the following. Field coating shall be in accordance with the field priming schedule, the coating schedule, and the manufacturer's recommendations.

a. Exterior surface of the sludge hopper.
b. Surfaces not indicated to be shop finished and surfaces where blast cleaning can be performed in the field.
c. All interior ferrous metal surfaces except stainless steel on the digester cover.
d. Other items as otherwise specified.

3-9. METAL SURFACES COATING SCHEDULE.

Surface To Be Coated	Finish Coating System
Non-galvanized structural and miscellaneous steel exposed to view or to the elements in exterior locations.	A6
Non-galvanized structural and miscellaneous steel exposed to view inside buildings.	A2
Steel handrails, steel floor plates.	A8
Unless otherwise specified, pumps, motors, speed reducers, and other machines and equipment exposed to view.	E8
Actuator surfaces for sluice gates, slide gates, unless factory finished.	Outdoor – E7
Metal curbs for skylights and power roof ventilators.	A1

Surface To Be Coated	Finish Coating System
Heating and air conditioning units, convector covers, electrical equipment cabinets, and similar Items and equipment (unless factory finished) exposed to view.	E8
Steel yard lighting poles exposed to view or to the elements.	A8
Cast Iron and steel piping inside buildings, including piping to be insulated, valves, fittings, flanges, bolts, supports, and accessories, and galvanized surfaces after proper priming.	A2
Cast Iron and steel piping above grade exposed to the elements and to view outdoors, including piping to be insulated, valves, fittings, flanges, bolts, supports, and accessories, and galvanized surfaces after proper priming.	A6
Copper pipe and tubing, including fittings and valves.	F1
Copper pipe and tubing, including fittings and valves exposed to view in exterior locations.	F7
Enclosed type screw pumping equipment, all iron and steel exterior surfaces exposed to UV except stainless steel, motors, and speed reducers.	E7
Open type screw pumping equipment, all iron and steel exterior surfaces exposed to UV except stainless steel, motors, and speed reducers.	E7
Open type screw pumping equipment, all iron and steel interior surfaces including the screw surfaces except stainless steel, motors, and speed reducers.	E4
All metal surfaces, unless otherwise specified, which will be submerged or buried, all or in part, including valves, and scum baffles, and cast iron slide gates, but excluding piping laid in the ground.	E4 or, where required, E5

Surface To Be Coated	Finish Coating System
All fully or partially submerged surfaces of screening, grit removal, aeration mixing, and sludge mixing equipment.	E4
Miscellaneous castings, including manhole rings and covers, and manhole steps. (One coat, if not shop coated.)	E2
Cast iron and steel piping in manholes, wetwells, grit basin, aeration basin, and similar locations, including valves fittings, flanges, bolts, supports, and accessories.	A4
All metal harness anchorage for buried piping.	A10
Exterior surfaces of carbon steel chemical tanks.	Outdoor – A6
Supports and miscellaneous metal for equipment handling corrosive chemicals.	Outdoor – A6 Indoor – A2
Aluminum in contact with concrete.	F1
Engine exhaust piping.	H12
Aluminum and galvanized ductwork and conduit indoors.	F1 or G1
Aluminum and galvanized ductwork and conduit exposed to elements outdoors.	F6 or G6
Aluminum materials exposed to the elements outdoors.	F6

3-10. CONCRETE AND MASONRY SURFACES COATING SCHEDULE.

Surface To Be Coated	Finish Coating System
All concrete and concrete block in corrosive area (Except floors and surfaces scheduled to receive other coatings) which are exposed to view.	Indoor –C2 Outdoor –C7
Concrete block surfaces in janitors closets.	C2
Where indicated on the Drawings, walls, floors, and curbed areas, adjacent to corrosive chemical storage and feed equipment.	C2

3-11. MISCELLANEOUS SURFACES COATING SCHEDULE.

Plastic Surfaces, including PVC and FRP only where indicated	Outdoor – P6 Indoor – P2
Piping Insulation only where indicated	Outdoor – P6 Indoor – P2

3-12. PIPING IDENTIFICATION SCHEDULE. Exposed piping and piping in accessible chases shall be identified with lettering or tags designating the service of each piping system, marked with flow directional arrows, and color coded.

Piping scheduled to be color coded shall be completely coated with the indicated colors, except surfaces specified to remain uncoated shall include sufficiently long segments of the specified color to accommodate the lettering and arrows. All other piping shall be coated to match adjacent surfaces, unless otherwise directed by Design-Builder.

3-12.01. Location. Lettering and flow direction arrows shall be provided on pipe near the equipment served, adjacent to valves, on both sides of wall and floor penetrations, at each branch or tee, and at least every 50 feet in straight runs of pipe. If, in the opinion of Design-Builder, this requirement will result in an excessive number of labels or arrows, the number required shall be reduced as directed.

3-12.02. Metal Tags. Where the outside diameter of pipe or pipe covering is 5/8 inch or smaller, aluminum or stainless steel tags shall be provided instead of lettering. Tags shall be stamped as specified and shall be fastened to the pipe with suitable chains. Pipe identified with tags shall be color coded as specified.

3-12.03. Lettering. Lettering shall be painted or stenciled on piping or shall be applied as snap-on markers. Snap-on markers shall be plastic sleeves, Brady "Bradysnap-On B-915", Seton "Setmark", or equal. Letter size shall be as follows:

Outside Diameter of Pipe or Covering	Minimum Height of Letters
5/8 inch [15 mm] and smaller	Metal tags -1/4 inch [6 mm]
3/4 to 4 inches [20 to 100 mm]	3/4 inch [20 mm]
5 inches [125 mm] and larger	2 inches [50 mm]

3-12.04. Color Coding and Lettering. All piping for the following services shall be color coded. Bands shall be 6 inches [150 mm] wide spaced along the pipe at 5 foot [1.5 m] intervals. For services not listed, the color coding and lettering shall be as directed by the Design-Builder.

Piping Identification		
Service	**Color of Pipe**	**Color of Letters**
Fire Protection Water	Red	White
Nonpotable Water (downstream of backflow preventer)	Purple	Black[2]
Potable Water (hot or cold)	Dark blue	White[4]
All other piping	Grey	Black

Notes:

1. Lettering shall read, “CAUTION: NONPOTABLE WATER, DO NOT DRINK”.
2. Lettering shall be on a yellow background and shall read, “CAUTION: NONPOTABLE WATER, DO NOT DRINK”. Each outlet on the nonpotable water line shall be similarly labeled.
3. Lettering shall read, “CAUTION: RECLAIMED WATER, DO NOT DRINK”.
4. Lettering shall be on a light green background.

Electrical conduit shall be coated to match adjacent ceiling or wall surfaces as directed by Design-Builder. Vent lines shall be coated to match surfaces they adjoin.

In addition, special coating of the following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes

Numerals at least 2 inches high shall be painted on or adjacent to all accessible valves, pumps, flowmeters, and other items of equipment which are identified on the Drawings or in the Specifications by number.

End of Section

SURFACE DESCRIPTION	SYSTEM NO. -

SURFACE PREPARATION DESCRIPTION
☐ Solvent SSPC-SP1
☐ Ferrous Metal Nonimmersion SSPC-SP6
☐ Ferrous Metal Immersion
☐ SSPC-SP10
☐ SSPC-SP-5
☐ Other

COATING	DFT mils [µm]	MANUFACTURER AND PRODUCT
First Coat (Primer)		
Second Coat		
Third Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:		
Coatings Manufacturer:		Initials _____
Painting Applicator:		Initials _____
BLACK & VEATCH	COATING SYSTEM DATA SHEET	Fig 1-09 96 11

SHOP PRIMED SURFACE DESCRIPTION	SYSTEM NO. -	-F

SURFACE PREPARATION DESCRIPTION
☐ Solvent SSPC-SP1 ☐ Other:

COATING	DFT mils [µm]	MANUFACTURER AND PRODUCT
Shop (Primer)		(Identify Product/Type)
Touchup		
Intermediate Coat		
Finish Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:		
Coatings Manufacturer:		Initials _____
Painting Applicator:		Initials _____
BLACK & VEATCH	COATING SYSTEM DATA SHEET	Fig 2- 09 96 11

Section 09 97 24

CORROSION PROTECTION SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing and installation of corrosion protection systems to be applied to floors and walls at the chemical storage facilities and RO CIP area as specified herein and as indicated on the Drawings. This section covers concrete surface preparation, furnishing and application of a corrosion protection system suitable for each set of specified service conditions, the engineering field services to be provided by the material manufacturer and applicator as well as any appurtenances that are required to provide a completed corrosion protection system.

1-2. QUALITY ASSURANCE.

1-2.01. Manufacturer's Field Services. The field services provided by the material manufacturer shall include review of the project before surface preparation; certification of the manufacturer's product for the application; approval of the applicator, the materials, and the procedure to be used; approval of the surface preparation; and approval of the application.

A representative of the corrosion protection system material manufacturer shall submit, through Contractor, written approvals/certification of the proposed protection system materials, application procedures, applicator, and surface preparation requirements.

1-2.02. Applicator Field Services. The Applicator of the corrosion protection system shall contact the corrosion protection system material manufacturer during the bidding phase of the project and shall include in the cost of this work and the estimated cost of the manufacturers engineering field services as specified.

The corrosion protection system Applicator shall submit a satisfactory experience record including references for previous application of the specified corrosion protection systems to concrete structures of similar design and complexity. After the application is complete, the Applicator of the corrosion protection system shall certify that the corrosion protection system is free of pinholes and holidays.

The Applicator shall also perform and provide the adhesion testing and results to determine compliance with the specified minimum pull-off adhesion strength.

Following the application, the Applicator shall certify that the corrosion protection system is free of pinholes and holidays.

1-3. SUBMITTALS. In accordance with the Submittals Procedures section, complete specifications and data on the protection system, application instructions for the protection system, and material manufacturer's approvals for the protection system furnished under this section shall be submitted for Design-Builder review. The lining manufacturer shall submit acceptable lining termination details and metal accessories encapsulation details

1-4. DELIVERY, STORAGE, AND HANDLING. The material shall be delivered to the jobsite in original unopened containers with labels intact. Protection system components shall be stored indoors in an appropriate location and environment in accordance with the manufacturer's recommendations and shall be protected against freezing.

Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with manufacturer recommendations and this section.

1-5. WARRANTY. Material manufacturer shall warrant the chemical resistance of each corrosion protection system (products and labor) for a period of three years from the date of Substantial Completion when exposed to the customer's normal operating conditions as stated in the specification.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS.

2-1.01. General Service Conditions. The corrosion protection system shall provide splash and spill protection for 72 hours from the chemicals as specified herein.

2-2. MATERIALS. Materials shall be suitable for the specified service conditions. Products composing the corrosion protection system shall be chemically resistant to the chemicals, concentrations, temperatures, exposure times, and other relevant service conditions. In many cases, repair materials, primers, flexible basecoats, and other ancillary products that will be protected by a corrosion resistant and/or wear resistant layer of the protection system and may not be required to meet these criteria provided the overall protection system complies with the performance criteria.

Corrosion protection systems specified herein shall be the type of product/system specified for the services and shall be the products of Dudick Inc., Carboline Company, Tnemec Company, International Paint, LLC/Ceilcote, Stonard, without exception. The products of other manufacturers and/or their corrosion protection systems will not be acceptable.

2-2.01. Epoxy Protection Systems.

2-2.01.01. Service Conditions for Epoxy Protection Systems.

Chemicals to be contained at the maximum chemical temperature of 120°F that are corrosive to concrete:

Sodium bisulfite; 38% conc.

Anti-Scalant

Chemicals to be contained at the maximum chemical temperature of 120°F that are not corrosive to concrete, do not stain concrete, and are not hazardous to the environment:

Polymer.

Epoxy protection systems will be exposed to sunlight, UV, and outdoor atmosphere.

2-2.01.02. System Requirements for Epoxy Protection Systems.

Type of lining system.	Coating, non-reinforced, and Lining, with reinforced with flexible basecoat.
Location(s) where coating corrosion protection system is required:	Polymer area within sludge facility.
Location(s) where mat reinforce with flexible basecoat lining system is required:	RO CIP area (including trench), anti-scalant area within chemical facility, sodium bisulfite area within chemical facility.

2-2.01.03. Epoxy Coating Protection System. When an epoxy coating lining system is required, the epoxy corrosion protection system shall be a two-component, 100 percent solids, solvent-free, epoxy resin, silica filled, high-build protective and waterproofing coating. All resins in this system shall be 100 percent solids with at least two components. The concrete surface primer shall be an epoxy resin primer containing 100 percent solids. The finish coats shall be amine cured epoxy resin.

2-2.01.04. Epoxy Flexible Lining Protection System. When an epoxy lining system with a flexible basecoat is required, the corrosion protection system shall be a two-component, 100 percent solids, solvent-free, epoxy resin, silica filled, fiberglass mat reinforced flexible basecoat, high-build protective and waterproofing lining. All resins in this system shall be 100 percent solids with at least two components. The concrete surface primer shall be an epoxy resin

primer containing 100 percent solids. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. The basecoat shall be a flexible epoxy resin with silica fillers with a chopped strand mat reinforcement and saturant. The finish coats shall be epoxy resin.

2-2.02. Vinyl Ester Protection Systems.

2 -2.02.01. Service Conditions for Vinyl Ester Protection Systems.

Chemicals to be contained at the maximum chemical temperature of 120°F that are corrosive to concrete:

Citric acid; 34% conc.

Vinyl ester protection systems will be exposed to sunlight, UV, and outdoor atmosphere.

2-2.02.02. System requirements for Vinyl Ester Protection Systems.

Type of lining system.	Lining, mat reinforced with flexible basecoat.
Location(s) where a mat reinforced with flexible basecoat lining corrosion protection system is required:	Citric acid area within chemical facility

2-2.02.03. Vinyl Ester Coating Protection System. Not used.

2-2.02.04. Vinyl Ester Rigid Lining Protection System. Not used.

2-2.02.05. Vinyl Ester Flexible Lining Protection System. When a vinyl ester lining system with a flexible basecoat is required, the corrosion protection system shall be a two component, 100 percent solids, solvent-free, high-build protective and waterproofing lining. Concrete surface primer shall be an epoxy resin primer containing 100 percent solids. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. Flexible basecoat with reinforcement shall be epoxy resin with silica fillers. Reinforcement shall be chopped strand mat. Saturant for reinforcement shall be epoxy resin. Finish coats shall be a two component, 100 percent solids, solvent-free, vinyl ester resin.

2-2.03. Vinyl Ester with Graphite Filler Protection Systems.

2-2.03.01. Service Conditions for Vinyl Ester with Graphite Filler Protection Systems.

Chemicals to be contained at the maximum chemical temperature of 120°F, unless otherwise indicated, that are corrosive to concrete:

Sodium hydroxide; 150°F.

Sodium hypochlorite; up to 15% conc.

Vinyl ester with graphite filler protection systems will be exposed to sunlight, UV, and outdoor atmosphere.

2-2.03.02. System requirements for Vinyl Ester With Graphite Filler Protection Systems.

Type of lining system.	Lining, mat reinforced with flexible basecoat.
Location(s) where a mat reinforced with flexible basecoat lining corrosion protection system is required:	Common sodium hypochlorite / sodium hydroxide storage area within chemical facility (including the truck unloading pit).

2-2.03.03. Vinyl Ester with Graphite Filler Coating System. Not used.

2-2.03.04. Vinyl Ester with Graphite Filler Rigid Lining System. Not used.

2-2.03.05. Vinyl Ester with Graphite Filler Flexible Lining System. The corrosion protection system shall be a two component, 100 percent solids, solvent-free, vinyl ester resin, graphite filled, mat reinforced flexible basecoat, high-build protective and waterproofing lining. Concrete surface primer shall be an epoxy resin primer containing 100 percent solids. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. Flexible basecoat with reinforcement shall be epoxy resin with silica fillers. Reinforcement shall be chopped strand mat. Saturant for reinforcement shall be epoxy resin. Finish coats shall be a two component, 100 percent solids, solvent-free, graphite filled vinyl ester resin.

2-2.04. Novolac Vinyl Ester Protection Systems. Not used.

2-2.05. Novolac Epoxy Protection Systems.

2-2.05.01. Service Conditions for Novolac Epoxy Protection Systems.

Chemicals to be contained at the maximum chemical temperature as indicate that are corrosive to concrete:

Sulfuric acid; up to 98% conc. at 150°F.

Novolac epoxy protection systems will be exposed to sunlight, UV, and outdoor atmosphere.

2-2.05.02. System requirements for Novolac Epoxy Protection Systems.

Type of lining system.	Lining, mat reinforced with flexible basecoat.
Location(s) where a mat reinforced with flexible basecoat lining corrosion protection system is required:	Sulfuric acid storage and feed area within chemical facility.

2-2.05.03. Novolac Epoxy Coating Protection System. Not used.

2-2.05.04. Novolac Epoxy Rigid Lining Protection System. Not used.

2-2.05.05. Novolac Epoxy Flexible Lining Protection Systems. The novolac epoxy corrosion protection system shall be a two component, 100 percent solids, solvent-free, novolac epoxy resin, silica filled, high-build protective and waterproofing coating. Concrete surface primer shall be an epoxy resin containing 100 percent solids. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. Flexible basecoat with reinforcement shall be an epoxy resin with silica fillers and chopped strand fiberglass mat. Saturant for reinforcement shall be epoxy resin. Finish coats shall be a two component, 100 percent solids, novolac epoxy resin.

2-2.06. Epoxy Filler Compound. Epoxy filler compound for concrete surfaces shall be a two-component, 100 percent solids epoxy filler or as recommended by the corrosion protection system material manufacturer.

2-2.07. Corrosion Resistant Caulking/Sealant. Chemical resistant caulking/sealant shall be suitable for the specified service conditions and shall be as recommended, in writing, by the protection system material manufacturer.

2-2.08. Reinforced Epoxy Resin Topping Systems. The topping/lining shall provide abrasion resistance and splash and spill resistance for 72 hours at the polymer storage and feed area.

The corrosion protection system shall be a three-component, 100 percent solids, epoxy resin, silica filled, protective and waterproof topping with a heavy-duty reinforcement layer of woven roving. Concrete surface primer shall be an epoxy resin primer containing 100 percent solids. The topping corrosion protection system shall be certified by the material manufacturer as capable of at least 10 mils of differential movement without damaging the corrosion protection system.

2-2.09. Reinforced Vinyl Ester Resin Topping Systems. Not used.

2-2.10. Reinforced Vinyl Ester with Graphite Resin Topping Systems. Not used.

2-2.11. Reinforced Novolac Vinyl Ester Resin Topping Systems. Not used.

2-2.12. Reinforced Novolac Epoxy Resin Topping Systems. Not used.

PART 3 - EXECUTION

3-1. GENERAL. All details, methods, and procedures of mixing, surface preparation, bonding, application, finishing, curing, and protection of the protection system shall be in strict accordance with the recommendations of the material manufacturer. The applicator shall comply with the recommendations of the material manufacturer.

3-2. SURFACE PREPARATION. All surfaces shall comply with the SSPC/NACE guidelines for surface preparation as specified herein and shall meet the manufacturer's recommendations for surface preparation.

All surfaces shall be dry when coated or lined, and shall be free from dirt, dust, sand, mud, oil, grease, rust, mill scale, and other objectionable substances. Oil and grease shall be completely removed as recommended by the material manufacturer before mechanical cleaning is started.

3-2.01. Concrete Surfaces. Concrete surfaces shall be prepared in accordance with SSPC-SP13/NACE 6 and the lining material manufacturer's recommendation. Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film.

New concrete shall be cured for at least 28 days before lining is applied and shall be ready to receive the lining as determined by the Applicator and material manufacturer. Concrete surfaces shall be tested for capillary moisture in the concrete in accordance with ASTM D4263. There shall be no capillary moisture migration after 24 hours as determined by the test method. If moisture is observed, the corrosion protection system shall include a vapor barrier that is recommended by the protection system manufacturer.

All concrete surfaces to be lined shall be cleaned in accordance with ASTM D4258 and abrasive blasted in accordance with ASTM D4259. Before the lining is applied, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. The Contractor shall repair all concrete surfaces that have spalls, voids, and cracks and shall remove all fins and other surface projections to produce a flush surface for application of the protection system.

Surface profile shall be at least 4 mils for a coating protection system and at least 22 mils for a lining protection system, but shall not be less than 25 percent of the dry film thickness specified for the corrosion protection system or 40-60 grit sandpaper unless recommended otherwise by the material manufacturer.

Concrete surfaces shall be pinhole free as using an epoxy concrete filler or as recommended by the material manufacturer and acceptable to Design-Builder.

3-2.01.01. Existing Concrete. Not used.

3-2.01.02. Adhesion Testing. Adhesion testing shall be conducted, by the Applicator, at each application area, after the concrete surfaces has been prepared and approved by the Applicator and lining material manufacturer. Adhesion strength test results shall exceed 400 psi or a higher value if recommended by material manufacturer. Adhesion test results shall be presented to and approved by Design-Builder.

The test area shall be at least 2 square feet to allow a minimum of three tests to be conducted. Pull-off strength adhesion tests shall be conducted by the Applicator in accordance with ASTM D7234 for concrete surfaces using an Elcometer tensile adhesion tester. At least three adhesion tests shall be conducted and the results averaged. Adhesion strength shall equal or exceed the minimum adhesion strength specified herein and by the material manufacturer.

3-2.02. Metal Surfaces. Metal surfaces shall be prepared in accordance with the following: All sharp edges, and corners are to be ground smooth, welds are to be ground smooth, in accordance with NACE standard RP0 178, Appendix C. Designation C, shall have all weld slag and splatter removed and be free of all defects. The surfaces shall be abrasive blasted in conformance with SSPC SP-10 and shall be at least a 3 mil surface profile.

3-3. MIXING AND THINNING. Materials shall be thoroughly mixed each time any is withdrawn from the container, and the containers shall be kept tightly closed except while the material is being withdrawn.

Corrosion protection system components shall be mixed to proper consistency and viscosity in accordance with the manufacturer's recommendations. Thinning will not be permitted. No adulterant, unauthorized thinner, or other material not

included in the formulation, shall be added to the protection system components for any purpose.

3-4. APPLICATION. Corrosion protection systems shall be applied in accordance with the manufacturer's recommendations and in a neat manner, with finished surfaces free of runs, sags, ridges, laps, and brush marks. In no case shall the dry film thickness of applied protection system be less than the thickness recommended by the material manufacturer.

Grit shall be broadcast into first finish lining coat to produce an anti-skid surface.

Each coat shall be applied over the previous coat in accordance with the recommendations of the material manufacturer. Each coat shall be applied in a manner that will produce an even film of uniform and proper thickness. In no case shall coating be applied at a rate of coverage which is greater than the maximum rate recommended by the material manufacturer.

Recoating shall be applied in accordance with manufacturer's recommendations.

Alternate coats shall be of contrasting colors to facilitate in obtaining complete coverage. The first coat shall be a dark color.

Corrosion protection systems showing checks, blisters, excessive sags, teardrops, or fat edges will not be acceptable and shall be entirely removed and the surface recoated. The protection system shall be free of pinholes and holidays.

Corrosion protection systems shall be applied when surface temperature is at least 50°F and at least 5°F above dewpoint, and relative humidity is 85 percent or lower. Protection system shall not be applied in direct sunlight or when the temperature of the concrete is rising. Preferably the protection system shall be applied when the temperature of the concrete is dropping.

When applying high build protection system with a roller or brush and where a dry film thickness of at least 4 mils per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

3-4.01. Epoxy Protection Systems.

3-4.01.01. Epoxy Coating Protection System. Epoxy coating corrosion protection system shall be applied in three or more coats. The system shall consist of one prime coat and two or more finish coats. The prime coat shall be at least 6 mils wet film thickness (WFT). Each finish coat shall be 6-8 mils dry film thickness (DFT). The protection system shall have a total thickness of at least 20 mils DFT.

3-4.01.02. Epoxy Flexible Lining Protection System. The corrosion protection system shall be applied in four or more coats. The system shall consist of one prime coat, one basecoat with reinforcement and saturant, and two or more finish coats. The prime coat shall be at least 6 mils wet film thickness (WFT). The basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 8 mils dry film thickness (DFT). The protection system shall have a total thickness of at least 90 mils DFT.

3-4.02. Vinyl Ester Protection Systems.

3-4.02.01. Vinyl Ester Coating Protection System. Not used.

3-4.02.02. Vinyl Ester Rigid Lining Protection System. Not used.

3-4.02.03. Vinyl Ester Flexible Lining Protection System. The corrosion protection system shall be applied in four or more coats. The protection system shall consist of one prime coat, one basecoat, reinforcement and saturant, and two or more finish coats. The prime coat wet film thickness shall be at least 5 mils. The basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 15-20 mils dry film thickness. The protection system shall have a total dry film thickness of at least 100 mils.

3-4.03. Vinyl Ester with Graphite Filler Protection Systems.

3-4.03.01. Vinyl Ester with Graphite Filler Coating System. Not used.

3-4.03.02. Vinyl Ester with Graphite Filler Rigid Lining System. Not used.

3-4.03.03. Vinyl Ester with Graphite Filler Flexible Lining System. The corrosion protection system shall be applied in four or more coats. The corrosion protection system shall consist of one prime coat, one basecoat, reinforcement and saturant, and two or more finish coats. The prime coat wet film thickness shall be at least 5 mils. The flexible basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 15-20 mils dry film thickness. The protection system shall have a total dry film thickness of at least 100 mils.

3-4.04. Novolac Vinyl Ester Protection Systems. Not used.

3-4.05. Novolac Epoxy Protection Systems.

3-4.05.01. Novolac Epoxy Coating Protection System. Not used.

3-4.05.02. Novolac Epoxy Rigid Lining Protection System. Not used.

3-4.05.03. Novolac Epoxy Flexible Lining Protection Systems. The corrosion protection system shall be applied in four or more coats. The protection system shall consist of one prime coat, one basecoat, reinforcement and saturant, and two or more finish coats. The prime coat wet film thickness shall be at least 4 mils. The basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 15-20 mils dry film thickness. The protection system shall have a total dry film thickness of at least 100 mils.

3-4.06. Epoxy Filler. An epoxy filler shall be used in a 1-inch minimum radius to fill in floor to wall joints for a liquid tight joint.

3-4.07. Corrosion Resistant Caulking/Sealant. Corrosion resistant caulking/sealant shall be used at any penetration in the lining, such as at anchorage of pipe supports and chemical storage tanks.

3-4.08. Topping System. The reinforced resin topping systems shall be applied when surface temperature is 50^{o}F or higher and relative humidity is 90 percent or lower. Toppings shall not be applied in direct sunlight or when the temperature of the concrete is rising. Preferably the topping shall be applied when the temperature of the concrete is dropping.

3-4.08.01. Bonding. Topping shall be bonded to a clean, dry, and properly prepared concrete surface and that has been coated with a concrete primer that is acceptable to the topping manufacturer and Design-Builder.

3-4.08.02. Minimum Thickness. Topping shall have a minimum thickness of 1/8 inch.

3-4.08.03. Finish. Topping shall receive a uniform trowel finish.

3-5. FIELD QUALITY CONTROL. Finished surfaces shall be cleaned and prepared as needed to properly conduct the visual inspection, spark testing, and adhesion testing. All inspection and testing shall be witnessed by Applicator and Material Manufacturer. Repairs shall be acceptable to Design-Builder.

3-5.01. Visual Inspection. The surface of the liner shall be visually inspected for areas defects, air inclusion, pinholes, or other imperfections in the system that may prevent a complete seal of the surfaces.

3-5.02. Spark Testing. Where practical, after liners are installed, the applicator shall spark-test all lined metal surfaces using an acceptable high-voltage electrical spark tester set at the recommended voltage. The material manufacturer shall verify the testing equipment is working properly before beginning the spark testing of the lining. The electrode movement shall be continuous and shall proceed in a systematic manner that will cover 100 percent of the lining surface.

3-5.03. Adhesion Testing. The Design-Builder reserves the right to require adhesion testing of any finished corrosion protection system application specified herein. Adhesion testing shall be conducted as specified in Paragraph 3-2.01.01 above by the Applicator. Adhesion strength test results shall exceed 300 psi or a higher value. Finished system adhesion test results shall be presented to and approved by Design-Builder, Applicator, and lining material manufacturer. Following adhesion testing, the area(s) tested shall be repaired by the Applicator with the specified products and methods specified herein.

If the finished system fails an adhesion test, the cause of the failure shall be determined and corrected before the test is repeated on a new test area. If the adhesion test fails a second time, the Design-Builder reserves the right to require the entire surface to be completely removed and reapplied at no cost.

3-5.04. Film Thickness. Coating film thickness shall be verified by measuring the wet film thickness of each coat as it is applied and the dry film thickness of the entire system. Wet film thickness shall be measured with a gauge that will measure the wet film thickness within an accuracy of ±0.5 mil. Dry film thickness for concrete shall be measured using a Defelsko Positector 200 series or equal, in accordance with SSPC-PA9 (concrete) and PA2 (steel). At the discretion of the Design-Builder, core samples could be obtained for measuring dry film thickness.

3-6. PROTECTION. Care shall be taken to prevent coating from being dropped or spilled on adjacent surfaces, buildings, structures, or facilities. All surfaces so damaged shall be cleaned, repaired, replaced, or painted as acceptable to Design-Builder.

End of Section

Section 10 12 16

TOILET PARTITIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Solid phenolic toilet partitions.

1.02 RELATED WORK

A. Section 09 25 00 - Gyspum Drywall.

B. Section 09 30 00 - Ceramic Tile.

C. Section 10 28 00 - Toilet Accessories.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 01330.

B. Shop drawings shall indicate location and type of connection to wall and ceiling structure.

C. Submit product data under provisions of Section 01330.

D. Product data shall include manufacturer's color selector, identifying immediate availability colors and custom order colors.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver , store and protect products per manufacturer's published recommendations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Bobrick.

B. Santana.

C. Equivalent products of other manufacturers will be acceptable on basis of submittals made under provisions of Section 01330.

2.02 TOILET PARTITIONS

A. Provide toilet partitions as indicated on drawings.

B. Characteristics:

1. Model: Bobrick "SierraSeries 109", Class A.
2. Materials: solid phenolic resin panels with stainless steel fittings and trim.
3. Support: Overhead braced.
4. Accessories: privacy thumblatch, pull, and coathook.
5. Finish: smooth, integral pigment.
6. Color: as selected by Architect from full color range of standard colors.

2.03 OTHER MATERIALS

A. Install any backing which may be required at ceiling or wall to support toilet partitions/urinal screens.

B. Provide any other items or materials, not specifically described herein, which are needed for a complete and functional installation.

PART 3 - EXECUTION

3.01 EXISTING CONDITIONS

A. Inspect ceiling and wall framing at area to receive toilet partitions and urinal screens, and verify that installation may be made in compliance with manufacturer's recommendations.

B. Inspect ceiling and wall surfaces again, after finishing of surfaces, and confirm that the substrate is ready for installation to commence.

C. Bring any problems, or conditions which prevent proper installation of toilet partitions and urinal screens to the attention of the Architect.

D. Beginning the work of installation means acceptance of the substrate.

3.02 INSTALLATION

A. Install all toilet partitions where indicated on the drawings, anchoring all compartments firmly in place for long life under hard use.

3.03 INSPECTION AND ADJUSTMENT

A. Upon completion of the installation, visually inspect the entire work of this section, adjust all components for proper operation and straight alignment, and touch-up all scratches and abrasions to be completely invisible.

End of Section

Section 10 28 00

BATHROOM ACCESSORIES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Toilet and bath accessories.

1.02 RELATED WORK

A. Section 05 40 00 - Cold Formed Metal Framing.

B. Section 07 92 00 - Joint Sealants.

C. Section 09 25 00 - Gypsum Board.

D. Section 10 12 16 - Toilet Partitions.

E. Section 10 51 16 - Lockers and Benches.

1.03 REFERENCES

A. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

B. California Building Code Chapter 11B - Mounting Heights and Locations for Accessible Accessories.

1.04 SUBMITTALS

A. Submit manufacturer's product data under provisions of Section 01 33 00.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and protect accessories per manufacturer's published recommendations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - BATHROOM ACCESSORIES

A. Bobrick.

B. American Specialties Inc.

C. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

2.02 BATHROOM ACCESSORIES

A. Fixed Tilt Mirror: Bobrick B-293 1836.

B. Wall Mounted Soap Dispenser: Bobrick B-2111.

C. 36" Grab Bar: Bobrick B-5806-36.

D. 42" Grab Bar: Bobrick B-5806-42.

E. 2-Roll Surface Mounted Toilet Tissue Dispenser: Bobrick B-6867.

F. Surface Mounted Paper Towel Dispenser: Bobrick B-2620.

G. Recessed 12 Gallon Waste Receptacle: Bobrick B-3644.

H. Surface Mounted Sanitary Napkin Disposal: Bobrick B-254.

I. (not used)

J. Recessed Paper Towel Dispenser/Waste Receptacle: Bobrick B-39003.

K. Single Robe Hook: Bobrick B-76717.

L. Surface Mounted 60" Shower Curtain Rod, Curtain: Bobrick B-6047 X 60, 204-3.

M. Surface Mounted 36" Shower Curtain Rod, Curtain: Bobrick B-6047 X 36, 204-2.

N. Locker Bench: refer to Section 10 51 16.

O. (not used)

P. Locker Bench: refer to Section 10 51 16.

Q. 24" Mop and Broom Holder: Bobrick B-223 X 24.

R. Lockers: refer to Section 10 51 16.

S. Framed Mirror: Bobrick B-165, custom size.

T. Framed Mirror: Bobrick B-165, custom size.

U. Toilet Partitions: refer to Section 10 12 16.

V. Wall Mounted Soap Dispenser: Bobrick B-818615.

W. Surface Mounted Seat Cover Dispenser: Bobrick B-221.

X. Electric Hand Dryers: Bobrick B-7125.

Y. Flip-Up Accessible Shower Seat: Bobrick B-5191.

Z. 18" Grab Bar: Bobrick B-5806-18.

2.03 FASTENERS AND ACCESSORIES

A. Provide anchors, fasteners and other mounting accessories as recommended by the manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION

A. Deliver any inserts and rough-in frames to jobsite at appropriate time for building-in. Provide templates and rough-in measurements as required.

B. Confirm required backing is in place for all grab bars.

C. Before starting work notify Architect in writing of any conflicts detrimental to installation or operation of accessories.

3.02 INSTALLATION

A. Install accessories and trim in accordance with manufacturer's instructions.

B. Install true, plumb, and level, securely and rigidly anchored to substrate.

End of Section

Section 10 40 00

SIGNAGE

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Site signage.

B. Exterior and interior door and wall mounted signage.

C. All labor and materials necessary for a complete installation of the work of this Section, whether or not specifically described.

1.02 RELATED WORK

A. Section 08 11 00 - Metal Doors and Frames.

B. Section 08 15 40 - Fiberglass Doors and Frames.

C. Section 08 80 00 - Glass and Glazing.

D. Section 09 25 00 - Gypsum Drywall.

1.03 SUBMITTALS

A. Submit shop drawings, product data and materials list under provisions of Section 01 33 00. Include manufacturer's installation instructions.

B. Indicate on shop drawings all dimensions, thicknesses and mounting details, as well as copies of composited artwork for all painted, screened, or fabricated images.

C. Accompanying product data and materials list submit one letter and one numeral of each size, and a sample of each type of sign and plaque. Following approval, samples may be installed in the Work.

1.04 DELIVERY, STORAGE AND PROTECTION

A. Protect signs and letters prior to and after installation. Repair damage at no additional cost to Owner.

PART 2 - PRODUCTS

2.01 WALL AND DOOR PLAQUE SIGNS

A. Acceptable Manufacturer: Best Sign Systems (sales@bestsigns.com).

B. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 33 00.

C. Characteristics:
1. Product: Best HC200 ADA System
2. Construction: Multi-layer melamine.
3. Graphics: Graphic Blast etching, image raised 1/32".
4. Typeface: Upper case, sans serif letters with a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio between 1:5 and 1:10; Futura Demi Bold, or approved equivalent, as selected by Architect.
5. Mounting: Vinyl adhesive tape on door, wall or glass surface.
6. Colors: White on standard background color selected by Architect.
7. Shape: square corners, 6" x 9" or 9" x 9" unless otherwise noted.
8. Copy Size/Position: per approved shop drawings.
9. Braille: Grade 2 (contracted) Braille block per CBC.
10. Location/ Copy: Per Drawings and Sign Schedule.
11. Backer Panels: Blind plaque exactly matching sign plaque size/shape on backside of plaques mounted to glass.

2.03 VINYL LETTERING

A. Acceptable Manufacturer: any

B. Vinyl Lettering Characteristics:
1. Product: vinyl letters and symbols.
2. Typeface: Futura Demi Bold.
3. Color: white.
4. Location/Size/Copy: per Sign Schedule and Drawings.
5. Mounting: Reverse mounted to inside glass surface.

2.04 PARKING LOT SIGNS (Fire Lane, Accessible Parking)

A. Manufacturer: Any.

B. Characteristics:
1. Type: Painted metal; white-on-blue, blue-on-white, black-on-white image per Drawings.
2. Material: Galvanized sheet steel, minimum 18 gage.
3. Depth: 3/4 inch to 1-1/2 inch, based on manufacturer's standard for character size.
4. Mounting: Bolted to galvanized steel pipe.
5. Count: Per Drawings.
6. Copy: Refer to Drawings and City of Morro Bay requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are suitable and installed work of other trades is complete to the point where work of this section may properly proceed.

B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Install all material in accordance with approved shop drawings.

B. Install all exterior signage attachments in a manner resistant to tampering and vandalism.

C. Install all signage level, plumb and true to sign edges. Limit deviation from level to 1/8 inch over the length of complete image.

End of Section

Section 10 44 00

FIRE EXTINGUISHERS AND CABINETS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Fire extinguishers where indicated on Drawings.

B. Semi-recessed wall cabinets for Operations Building.

1.02 RELATED WORK

A. Section 05 40 00 - Cold Formed Metal Framing.

B. Section 07 90 00 - Joint Sealants.

C. Section 09 25 00 - Gypsum Drywall.

D. Section 09 90 00 - Paints and Coatings.

1.03 REFERENCES

A. NFPA 10 - Portable Fire Extinguishers.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 01 30 00.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer's operation and maintenance data under provisions of Section 01 70 00.

B. Include test, refill or recharge schedules, procedures, and re-certification requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Larsen's Manufacturing Company.

B. Alternate products may be used if approved on the basis of submittals made under provisions of Section 01 30 00.

2.02 EXTINGUISHERS

A. For Semi-Recessed Cabinets, Operations Building: Larsen's Model MP5; Type 2A:10B:C, hand held 5 pound.

B. For Surface Mounting, Other Locations: Larsen's Model MP10; Type 2A:10B:C, hand held 10 pound.

2.03 INTERIOR CABINETS

A. Larsen's Model 2409-R3, steel semi-recessed cabinet, recoatable factory white paint.

B. Glazing: Clear acryllic bubble.

C. Hardware: Full piano hinge, cam latch without lock, wall bracket.

2.04 INTERIOR SURFACE BRACKET

A. Larsen's Model 818, steel surface-mount bracket with cinch band.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify rough openings for cabinet are correctly sized and located.

B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Install cabinets plumb and level in wall openings as shown on drawings.

B. Secure rigidly in place in accordance with manufacturer's instructions.

C. Calk all around cabinets.

D. Install cabinets and extinguishers such that neither the top of the extinguisher nor the cabinet handle are more than 48 inches above the finished floor.

E. Install surface mount brackets firmly fastened to building structure.

End of Section

Section 13 34 19

METAL BUILDING SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers the design, fabrication and erection of the following framed pre-engineered metal building(s) and miscellaneous components.

Building Identification	Water Reclamation Facility	multiple structures
Location	Morro Bay, CA	

Earthwork, concrete, masonry, stairs, interior partitions and ceilings, floor finishes, plumbing, heating, ventilating, air conditioning, and electrical work are covered in other sections.

1-2. GENERAL. Building components and accessories shall be designed and erected in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the building manufacturer unless exceptions are noted by the Engineer.

The building dimensions shall be as indicated on the Drawings. Fascias, parapets, canopies, screens, and other architectural features shall be as indicated on the Drawings.

The building shall be furnished complete with all primary and secondary structural framing, bracing, connections, metal wall and roof coverings, flashings, closures, metal trim, fasteners, sealants, caulking, and all other accessories needed for a complete weathertight building, and other miscellaneous components or accessory items when required, as specified or indicated on the Drawings. Other appurtenant items such as crane runway beams, supports, and bracing; secondary framing for piping, roof ventilator curbs, conduit, and equipment hangers, etc.; shall be provided as indicated on the Drawings and as specified herein. Framing and connections shall be provided to transfer lateral and vertical loadings from any appurtenant items and secondary framing into the primary structural framing systems.

The building shall include framed openings and flashings for all doors, windows, louvers, and other openings as needed. Fixed and projecting windows shall be proprietary products provided by the building manufacturer. Fiberglass doors and frames, overhead coiling doors, storefront framing and entries, door hardware, glazing, skylights and louvers shall be as specified in other sections.

Miscellaneous components intended for use on other structures (matching roof or wall panels and girts, for example) shall be provided as indicated on the Drawings. Such components shall match the appearance of the pre-engineered metal buildings.

1-2.01. Coordination. The metal building erector shall coordinate with Engineer and Design-Builder for the erection and field quality control of the metal building and appurtenances, the erection of any hoisting equipment, installation of equipment, and the installation of any interior systems and finishes.

1-2.02. Governing Standards. The building design and erection shall comply with the codes indicated in the Meteorological and Seismic Design Criteria section.

The building design shall also comply wholly or in part, as specified herein, with the Metal Building Manufacturers Association (MBMA) "Metal Building Systems Manual". In case of conflicting requirements, the applicable building code shall govern.

Steel construction with hot-rolled structural shapes and plates shall be in accordance with AISC "Specifications for Structural Steel Buildings". Light gauge structural steel members shall be designed and detailed in accordance with AISI "Specifications for the Design of Cold-Formed Steel Structural Members". Welding shall be in accordance with AWS D1.1, Structural Welding Code - Steel.

Building erection shall comply with the applicable provisions of OSHA Standard 29 CFR 1926, Subpart R.

1-2.03. Manufacturer Certification. The building manufacturer shall be certified in accordance with the International Accreditation Service (IAS) metal building inspection program, IAS AC472.

1-3. DELIVERY, STORAGE, AND HANDLING. All factory finished materials shall be protected for shipment in accordance with accepted packaging standards. Minor damage to finishes shall be touched up before installation using color-matched, air-drying paint furnished by the manufacturer. No other finish will be acceptable. Any significantly damaged components shall be replaced at no cost to Owner. Anchor bolts and their accessories shall be delivered in time to avoid delays in placing concrete.

1-4. SUBMITTALS. The following items shall be submitted to Engineer for review prior to fabrication of the building elements. All drawings and data shall be submitted in accordance with the Submittals Procedures section.

Complete drawings and data showing anchor bolts, construction details, lateral thrust details, cross-sections, insulation, roof and wall panels, fasteners, accessories, locations of all openings, building elevations, panels colors when noted on Drawings, and flashing details. Drawings shall be sealed by a professional engineer registered in the state where the building is to be erected.

A letter of design certification listing the design criteria, including design codes, standards, loads, and other design information indicated in this section; and the structural calculations. The letter of design certification and the structural calculations shall be sealed by a professional engineer registered in the state where the building is to be erected.

All loads imposed by the metal building to the foundation.

Documentation of IAS AC472 certification.

Manufacturer's erection information indicating standard recommendations, erection details, and piece markings.

Samples of the manufacturers' available colors.

1-5. WARRANTY. After final acceptance, the completed structure shall be warranted by the metal building manufacturer to be completely weathertight under all weather conditions for a period of 20 years. Leaks which occur during the correction period, whether through roofs, walls, doors, or accessory equipment or materials, shall be repaired at no cost to, and to the satisfaction of, Owner's Representative.

The roof finish shall be warranted by the manufacturer for a period of 25 years. The wall finish shall be warranted by the manufacturer for a period of 25 years.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. Pre-engineered metal buildings shall be as manufactured by Varco-Pruden Buildings.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Minimum design loadings and requirements shall be in accordance with the applicable building code and as specified. Design data for determining seismic, wind, snow and ice loads shall be as indicated in the Meteorological and Seismic Design Criteria section. Load combinations shall be in accordance with the applicable building code.

The building shall be designed in accordance with the following requirements.

Building identification.	All indicated on Drawings
Minimum roof live load.	20 psf
Minimum roof uplift load.	Per building code
Minimum platform live load.	100 psf
Collateral roof dead load.	5 psf
Interior walls lateral load.	5 psf
Hoisting loads.	See Drawings for hoist/trolley locations and lifting capacities

Maximum permissible deflections.

Roof Panels	L/60 under the maximum full load condition.
Roof Purlins	Maintain positive drainage under dead plus the greater of (0.5) snow or 5 psf.
Roof Purlins (supporting a plaster or stucco ceiling, roof mounted equipment, or process piping)	L/240 under dead plus live, L/360 under the greater of roof live, snow, or wind.
Roof Purlins (supporting a non-plaster ceiling, and no equipment or process piping)	L/180 under dead plus live, L/240 under the greater of roof live, snow, or wind.
Roof Purlins (no ceiling, equipment, or process piping)	L/150 under the greater of roof live or snow.
Main Roof Members (supporting a plaster or stucco ceiling, cranes, equipment, or process piping)	L/240 under dead plus live, L/360 under the greater of roof live, snow, or wind.
Main Roof Members (supporting a non-plaster ceiling, and no cranes, equipment, or process piping)	L/180 under dead plus live, L/240 under the greater of roof live, snow, or wind.
Main Roof Members (no ceiling, cranes, equipment, or process piping)	L/120 under dead plus live, L/180 under the greater of roof live, snow, or wind.

Roof Purlins or Main Roof Members (with a partition wall below)	3/8 inch under the greater of 0.5(roof live) or snow.
Floor Beams or Girders	L/360 under dead plus live, L/240 under dead.
Floor Beams or Girders (supporting a non-plaster ceiling)	1 inch under dead.
Floor Beams or Girders (supporting a partition wall)	3/8 inch under 0.5(live).
Runway Beams for Top-Running (Bridge) Cranes	L/800 under crane vertical static load.
Runway Beams for Top Running (Bridge) Cranes	L/400 (horizontal) under crane lateral.
Runway Beams for Underhung Cranes	L/450 under crane vertical static load.
Runway Beam Supports	1/2 inch inward under live or snow, 1 inch outward under snow.
Machine/Sheave Beams at Elevators	L/1666 under dead plus live.
Machine/Sheave Beams Supports	H/1666 under dead plus live.
Girts and Wind Columns (providing horizontal support to metal wall panels)	L/120 under wind.
Girts and Wind Columns (providing horizontal support to CMU walls)	Lesser of L/240 or 1.5 inches under wind.
Girts and Wind Columns (providing horizontal support to plaster or stucco finishes)	L/360 under wind.
Bare Frame (providing horizontal support to metal wall panels)	H/100 under wind.
Bare Frame (providing horizontal support to precast concrete wall panels)	H/100 under wind.
Bare Frame (providing horizontal support to reinforced CMU walls)	H/200 under wind.

Bare Frame (providing horizontal support to metal panels)	H/100 under wind.
Bare Frame (providing horizontal support to metal panels)	H/100 under wind.
Bare Frame (next to a partition wall)	H/500 under wind.
Bare Frame (supporting top running cab operated crane)	Lesser of H/240 or 2 inches at the runway elevation, under the greater of wind or crane lateral.
Bare Frame (supporting top running pendant operated crane)	H/100 at the runway elevation, under the greater of wind or crane lateral.
Bare Frame (at elevators)	H/500 under wind.

Notes:

1. Wind load (for purposes of deflection calculations only) shall be 0.7 times the service level components and cladding pressure.

2. The roof live load or snow load shall not be reduced in consideration of the tributary area.

The building design shall account for all dead, live, and impact loads in accordance with the Metal Building Systems Manual, including conservative estimates for the hoisting equipment weights.

In addition, the building shall be designed to carry loads, including crane rails and runway beams, pipe and equipment, lateral loads of wall systems furnished by others, and other loads as indicated on the Drawings. Secondary framing to carry these loads to the main building frames shall be provided with the building system unless otherwise specifically noted on the Drawings.

Unless specifically authorized by Engineer in writing, for steel building design, columns and posts shall be considered "hinged" at their base. The building foundation shall not be required to accept either full or partial moment fixity from steel building columns or posts.

Masonry wall or wall cladding dead loads shall be considered as supported by the foundation and not the wall girts of the building.

Anchor rods shall be as specified in the Materials paragraph. Anchor rods and related anchorages shall be designed to resist column and brace reactions from loading combinations. The metal building manufacturer shall determine anchor

rod diameter, quantity, projection, and arrangement. Each column base plate shall have a minimum of four anchor rods, and the minimum spacing between anchor rods shall be six rod diameters. Anchor rod diameter shall be determined in accordance with ACI 318, Appendix D, assuming that a maximum of two anchor rods transfer shear forces from the columns to the foundation.

If additional shear capacity beyond the shear capacity of the anchor rods is required, a design utilizing shear lugs field welded to an embedded foundation weld plate shall be utilized. No shear lugs or bars on the underside of the base plate will be permitted unless approved by Engineer.

Bracing shall clear all openings indicated on the Drawings.

Girts shall be uninterrupted past outside column face as indicated on the Drawings.

Columns shall be tapered or straight-sided as indicated on the Drawings.

Metal roof systems shall be Class 90 in accordance with Underwriters' Laboratories "Tests of Wind-Uplift Resistance of Roof Assemblies - UL 580" and shall be listed for Class 90 in Underwriters' Laboratories "Building Materials Directory".

2-3. MATERIALS. Materials for the building shall be new and free from defects, and shall meet the following requirements unless otherwise indicated on the Drawings.

Frames and Structural Components	Steel, ASTM A36 or A572.
Structural Bolts	ASTM A325, black, for main framing. ASTM A307, black, for girts and purlins.
Anchor Rods and Nuts	Headed ASTM F1554, Grade 36 with compatible nuts and washers; hot-dip galvanized, ASTM A153 and A385. Heads may be provided by using a nut on a threaded shaft with mechanically deformed threads to prevent nut rotation.
Flat Washers	ANSI B18.22.1; of a material and with coating compatible with anchor bolts and nuts.
Secondary Framing	ASTM A1011 or A1008, cold-formed, with a minimum yield strength of 50 ksi.

Roof Panels	Varco-Pruden “SLRII”, without exception, 24 gage minimum, 45 ksi [310 MPa] minimum yield steel, with concealed clips.
Wall Panels	Varco-Pruden “ImpressaClad”, 16 inch wide at Operations Building lower walls, 20 gage 42 ksi minimum yield steel with concealed fasteners; and Varco-Pruden "Tech Four" elsehwere, 16 inch wide, 24 gage minimum 42 ksi minimum yield steel, with concealed fasteners.
Insulation (Roof and Designated Walls)	0.6 pcf [9.6 kg/m^3] density glass fiber blankets, faced with a white vinyl polyester scrim with a permeability rating of 0.02; Owens Corning Fiberglass Certified R-MBI; or acceptable equal.
Gutters and Downspouts	Minimum 26 gauge [0.45 mm] galvanized steel conforming to ASTM A653, G-90 coating with factory applied finish.
Flashing and Trim	Steel with factory applied painted finish or galvalume finish for non-painted areas.
Roof Ventilators	Apex 20 steel, 20-inch diameter vent and base for ridge mounting, Kynar finish to match roofing.
Exposed Fasteners	Self-tapping, carbon steel screws with AISI Type 302 stainless steel cap and metal-back neoprene washers, or as recommended by building manufacturer; screwheads capped or colored to match panel finish.
Sealant	As recommended by building manufacturer and acceptable to Engineer.
Miscellaneous Accessories	Manufacturers' standard.
Personnel Doors and Frames	Furnished by others.
Storefront and Entrance Systems	Furnished by others.
Windows	Wintech S250 Series Aluminum.

Type	Fixed or projecting as indicated in Window Schedules.
Frames	Aluminum extrusions, Alloy 6063, minimum 0.062 inch [1.57 mm] thick, with white finish.
Glazing	Plate or float glass, 1/4 inch [6 mm] thick, ASTM C1036, Type I, Class 1, Q3, clear, safety glass where indicated Window Schedules or required by code.
Glazing	Insulated low-E glass, 1 inch [19 mm] thick, ASTM E774, Class A; made from 1/4 inch [6 mm] plate or float glass and 1/2 inch [6 mm] air space, exterior and interior lights clear. Solar heat gain coefficient 0.28; U factor 0.50.
Louvers	Furnished by others; refer to Section 08 90 00.
Baseplate Grout (if required)	See Grouting section.
Touchup Painting	As recommended or as supplied by the building manufacturer.
Finish Painting of Structural Members	See Architectural Painting section.

2-4. FABRICATION. All primary framing shall be shop fabricated for bolted field assembly. Secondary framing shall have bolted or welded connections. All members shall be accurately shop punched. All framing members shall have an easily visible identifying mark.

2-4.01. Wall Panels. Wall panels shall be factory roll formed. Where possible, the panels shall be of one piece from base to eave. All side laps shall have a width of at least one full corrugation.

2-4.02. Roof Panels. Roof panels shall be factory roll formed, with a nominal coverage width of 24 inches [600 mm] and with two major corrugations per panel. Panels shall be of maximum length to minimize end laps.

2-4.03. Insulation. Insulation for walls and roof shall be noncombustible glass fiber blankets with 4 mil [100 µm] vinyl film facing, carrying an Underwriters' Laboratories fire hazard rating for a flame spread of 25 or less.

2-4.04. Trim and Flashings. Trim and flashing members shall be fabricated from the same materials and with the same finishes as the materials to which they are attached. Trim members shall be manufacturer's standard profiles for the use intended.

2-4.05. Gutters and Downspouts. Minimum gutter cross sectional area shall be as indicated on Drawings. Minimum slope of gutters shall be 1/8 inch/foot. The gutter apron shall extend under the roof panels to provide a positive counterflashing. The outside face of the gutter shall be supported with at least 16 gauge [1.52 mm] galvanized steel straps attached to the eave member at a spacing not to exceed 4 feet [1.2 m].

Minimum downspout cross sectional area shall be 12 sq inches. Each downspout shall have an elbow at the base and shall be supported with a minimum of 24 gauge [0.61 mm] galvanized steel clincher bands attached to the wall covering at a spacing not to exceed 10 feet [3.1 m]. The location of downspouts shall be as indicated on the Drawings.

Gutters and downspouts shall be finish coated to match the wall panels.

2-4.06. Anchor Rods. Contractor shall furnish anchor rods. Rod embedment shall be in accordance with the Drawings.

The diameter, quantity, projection, and arrangement of the anchor rods shall be based on information provided by the metal building manufacturer.

2-4.07. Hoist and Crane Runways. Hoist monorails and crane runway framing, including crane rails with necessary stops and appurtenances, shall be furnished as indicated on the Drawings and as specified in the Metal Building Systems Manual. Crane and hoist capacities, location and number, span, and travel shall be as indicated on the Drawings.

2-4.08. Roof Equipment Curbs. Roof equipment curbs shall be provided where indicated on the Drawings. The curbs shall have a water diverter on the up-slope side. The curb base profile shall match the adjacent roof panel profile. All corners shall be mitered and welded watertight. The curbs shall be reinforced as needed to support the equipment specified or indicated, including the seismic and wind forces thereon. The curbs shall be finished to match the adjacent roof panels.

2-4.09. Windows. Windows shall be provided at the locations and in the sizes indicated on the Drawings. The window types shall be as specified herein. Windows shall be provided complete with thermal broken frames, glazing, weatherstripping, insect screens, and accessories, and shall meet the applicable portions of AAMA Standard 101. Windows shall be glazed as specified herein.

All exposed surfaces of frames and accessories shall be finished with manufacturer's standard factory finish.

2-5. COATINGS. Unless otherwise required, finish on exposed surfaces of wall panels, roof panels, flashings, appurtenances, and trim shall be a baked-on 70% PVDF, “Kynar 500” or “Hylar 500”, minimum 0.8 mil thick, over a minimum 0.2 mil primer. Finish on sides concealed by insulation or interior finishes may be manufacturer’s standard.

Multiple colors shall be selected form the manufacturer’s standard color chart. A minimum of 20 colors shall be offered.

All steel parts which are not specified to be factory finished and which are not zinc coated shall be cleaned and shop primed.

Any surfaces abraded or damaged during fabrication shall be touched up or repainted. All welds shall be thoroughly cleaned and touched up with a suitable primer.

A suitable quantity of touchup paint shall be provided with the metal building.

2-6. WARRANTY. The roof and wall panel coating systems shall be warranted against cracking, fading, peeling, crazing, chipping, or other failure.

PART 3 - EXECUTION

3-1. ERECTION. Building parts shall be plumb and level with a tolerance as recommended by the metal building supplier. Fasteners shall be installed and tightened for all connections. High strength structural bolts shall be tensioned by any method set forth in the AISC Steel Construction Manual, except calibrated wrench. Necessary field welding shall be by certified welders in accordance with AWS D1.1, Structural Welding Code - Steel. Welders' qualifications shall be submitted in accordance with the Submittals Procedures section.

A copy of the building manufacturer's erection information shall be kept at the erection site at all times, and shall be available for all building trades.

The metal building erector shall be responsible for verifying prior to starting building erection that the anchor rods are correctly set in the field and the corresponding holes in the baseplates are properly located. If adjustments or corrections are necessary, they shall be submitted to Engineer for review prior to execution, and shall be made at no expense to Owner.

Roof and wall panels, flashings, closures, and other building components shall be installed and sealed to be weathertight. Panels shall be neatly cut and fitted around openings, door and window frames, and other installed accessories. All joints shall be lapped and sealed. Panels shall be securely fastened to structural framing and to each other.

Insulation shall be installed against covering and between supporting members and in a manner to present a neat appearance. Insulation shall have facing at joints lapped and fastened in a manner that will provide continuity of the vapor barrier at joints. The overall wall and roof construction details shall have water vapor transmission rates consistent with the requirements specified for the facing scrim.

Any gutters and downspouts shall be rigidly attached to the building. Gutters shall be installed to provide drainage and shall be designed with adequate provisions for expansion and contraction.

Snow guards shall be attached to the standing seams of the roof panels as per manufacturer's recommendations.

Windows, including frames and accessories, shall be securely anchored to the supporting construction, shall be installed plumb and true, and shall be adjusted as necessary to provide proper operation. All joints at doors and windows shall be sealed to provide weathertight construction and in accordance with the manufacturer's recommendations.

Any factory finished surfaces abraded or damaged during erection shall be repaired and the coating system touched up or repainted with manufacturer's touchup paint. All welds shall be thoroughly cleaned and prime painted.

Field painting of metal surfaces not finish painted at the factory is covered in the painting section.

3-2. FIELD TESTING. The building shall be leak tested with a garden hose stream prior to acceptance. Any leakage discovered shall be corrected and retested.

3-3. PROTECTION. All portions of the building shall be protected from damage during site storage and erection. Damaged parts shall be replaced with undamaged units unless field repairs are authorized by Engineer.

3-4. CLEANING. After completion of construction all soiled surfaces shall be cleaned in accordance with the manufacturer's instructions.

End of Section

Section 21 13 00

FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

This section covers the minimum design, shop fabrication, installation, and acceptance testing requirements for the fixed suppression systems. Fire protection equipment shall be arranged to appropriately protect the plant and equipment in the event of fire.

It is not the intention to specify herein all details of design and construction. The Subcontractor shall ensure that the equipment has been designed, fabricated, and erected in accordance with all engineering codes, standards, and governmental regulations applicable to the specified service.

The Subcontractor shall have full responsibility for compliance with the requirements of these specifications. Review and/or approval of drawings, data, or specifications by the Purchaser with regard to general design and controlling dimensions does not constitute acceptance of any designs, materials, or equipment that will not fulfill the functional or performance requirements established herein or local codes.

The Subcontractor shall provide and coordinate all the terminal points for interfacing the sprinkler system and water supply monitoring switches with building fire alarm control panel provided by Fire Alarm Signaling System (Section 28 31 16) Subcontractor. The combined systems shall be a complete and code compliant systems.

In case of a conflict within the technical requirements, the following hierarchy shall apply:

(1) Mandatory governmental/local regulations and codes.

(2) Purchaser-specified requirements provided herein.

(3) Requirements provided in the technical attachments.

(4) Requirements provided in the technical specifications.

(5) Referenced industry codes and standards and material specifications.

1-1. Scope of Work. The Subcontractor shall furnish complete fire protection systems including, but not limited to, the following: all sprinkler heads, strainers, OS&Y valves, sprinkler system piping, fittings, strainers, fire department

connections, backflow preventer assemblies, wall type post indicator valve, pipe hangers and supports, expansion joints, valve tamper switches, pressure switch, sprinkler system electric alarm bell, and instrumentation as required for complete fire protection system. Each system shall be designed to provide the required protection for the specific hazard.

At minimum, the Subcontractor shall supply wet sprinkler system in the Operations Building excluding sprinkler coverage for dedicated electrical rooms such as Operations Electrical and Server Room. Subcontractor shall be responsible to confirm that dedicated electrical rooms meet NFPA 13 requirements for exclusion of sprinkler coverage in a fully sprinklered building.

At minimum, the Subcontractor shall supply wet sprinkler system in the Maintenance Building excluding sprinkler coverage for dedicated electrical rooms. Subcontractor shall be responsible to confirm that dedicated electrical rooms meet NFPA 13 requirements for exclusion of sprinkler coverage in a fully sprinklered building.

The Subcontractor shall supply and install a backflow preventer assembly upstream of sprinkler system valve station to prevent water back flow into municipal water supply. The backflow preventer assembly shall meet AHJ requirements.

The Subcontractor shall supply and install a wall type post indicator valve at water supply connection into the building upstream of sprinkler system valve station. The wall type post indicator valve shall be provided with tamper switch rated for outdoor condition.

A minimum list of sprinkler systems with basic design parameters is included in the end of this section.

1-2. Items Furnished by Others and Interfaces. Items furnished by others and not in this Scope of Work include the following:

Monitoring and control wiring to connect the specified termination points on the fire protection system equipment and accessories to the building fire alarm system control panel.

Fire alarm control panel, smoke detectors, manual pulls, etc. are provided by fire alarm system supplier scoped under Section 28 31 16.

Piping required to connect building sprinkler system to water supply.

1-3. Performance and Design Requirements. Minimum performance and design requirements for the fire protection system are indicated herein and in the end of this Section.

1-4. Codes and Standards. Work performed under these specifications shall be done in accordance with the following codes and standards. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply:

Work	In Accordance With
Overall design	NFPA, AHJ, Local Building and Fire Codes, and applicable local jurisdiction requirements.
Sprinkler system	NFPA 13 and 820
Pipe thread tolerances	NFPA 13 and ANSI B1.20 Pipe Threads
*Equipment supplied shall be listed by Underwriters Laboratories Inc. (UL) or shall be included in the Approval Guide as published by Factory Mutual (FM) Engineering. Equipment shall be considered as FM-approved only if it conforms to the charac-teristics and limitations of the individual component approvals and if those components are used in the service intended by the Approval Guide.	

Any conflict between referenced codes or standards, or between the standards and these specifications, shall be referred immediately to the Purchaser who shall determine which standard or specification requirements shall govern.

1-5. Materials. The following materials shall be used:

Component	Material
Piping	
Wet-pipe systems (downstream of isolation gate valve)	Black steel, ASTM A53, Grade B, seamless; or ASTM A106, Grade B, seamless. Minimum Schedule 40

Component	Material
Piping upstream of the sprinkler and spray systems	Black steel, ASTM A53, Grade B, seamless; or ASTM A106, Grade B, seamless. Minimum Schedule 40
Piping downstream of backflow preventer	Standard Weight ASTM A53 schedule 40 with Flanged Fittings. Standard Weight ASTM A53 schedule 40 with Grooved-End Fittings. (optional)
Flanges	
Flanges	Hot-dip galvanized following welding when connected to galvanized pipe
Piping 2 inches (50 mm) and smaller	Screwed or shop welded.
Piping larger than 2 inches (50 mm)	Welded flanges or shop welded connections. (UL or FM Listed grooved style fittings are acceptable.)
Pipe accessories	
Sprinkler fittings (threaded or flanged: tees, couplings, elbows, caps, and reducers)	ANSI B16.3 or B16.1 malleable iron, Class 150 (mitered fittings are not acceptable)
Sprinkler fittings	Galvanized, ASTM A153; no bushing, slip type, or clamp-on rubber gasketed fittings (such as mechanical tee, saddle outlets, etc. not permitted)
Plugs (sprinkler system)	Square head, dissimilar to the fitting to which they are attached
Gaskets	Red rubber sheets, 1/16 inch (1.6 mm) thick, full face, ASTM D2000, No. 2AA705A13L14
Thread sealant	Teflon ribbon, Optional for gas suppression piping: Locktite 592 sealant and primer NF-73656
Thread tolerances	NFPA 13 and ANSI B1.20.1 pipe threads
Bolts and nuts	Steel machine bolts
Piping supports	Per NFPA 13
Supplementary support beams (pipe support)	ASTM A36, fireproof construction

Component	Material
Riser lugs	ASME B31.1
Hanger rods	Per NFPA 13
Water shields	Viking model B-1, or equivalent.
Valves	
Gate valves	OS&Y type, flanged ends
Temper Switch	Approved by AHJ
Backflow Preventer	Approved by AHJ
Wall Type Post Indicator Valve	Approved by AHJ

1-6. Not used.

1-7. Test Requirements. The following testing shall be conducted in accordance with the specified source. This testing is to be considered part of the defined Scope of Work, and all associated costs are the responsibility of the Subcontractor unless specifically identified as a Bid Option or Purchaser-conducted. Tests identified as an option are to be priced separately. If identified as Purchaser-conducted, costs for the initial test will be the responsibility of the Purchaser. However, the Subcontractor is responsible for all costs associated with correcting deficiencies and retesting in the event of a test failure:

Tests	In Accordance With	Conducted By
Testing and system acceptance of water based fire protection systems	NFPA 13, 25, and applicable building code	Subcontractor
Entire System	Applicable NFPA and Local Building codes and standards	Subcontractor

1-8. Technical Attachments. The following attachments accompany these specifications in either paper or electronic format. Plant areas or equipment to be protected by suppression systems and early warning detection are indicated on the drawings listed below. The information contained in these documents constitutes requirements under the defined Scope of Work:

Document Number/Description	Title
95-F-201	Operations Building Fire Suppression System Schematic
95-F-301	Operations Building Fire Suppression System Plan
96-F-201	Maintenance Building Fire Suppression System Schematic
96-F-301	Maintenance Building Fire Suppression System Plan

1-9. Not used.

PART 2 - PRODUCTS

2-1. Sprinkler Systems.

2-1.01. General. This article covers the sprinkler fire suppression systems to be designed, furnished, and installed under these specifications.

The Subcontractor shall furnish complete fire suppression systems, including all spray nozzles, sprinkler heads, valves, piping, fittings, strainers, pipe supports, expansion joints, and instrumentation as required for complete systems, from the Purchaser's piping connections as indicated on the drawings through sprinkler heads and/or spray nozzles. Each system shall be designed to provide the minimum required protection for the specific hazard. All equipment and devices furnished shall be designed to meet code requirements specified herein.

2-1.02. System Requirements. The fire protection equipment shall be arranged to adequately protect the plant and equipment in the event of fire. The minimum systems to be provided for protection of equipment and areas is indicated on the Fire Suppression System Plan drawing.

2-1.03. Arrangement. The minimum fire suppression systems to be provided, locations of the equipment to be protected, and other pertinent information are indicated on the drawings listed herein and on manufacturer's drawings. Any manufacturer's drawings the bidder may wish to review are available at the Purchaser's office by appointment only.

After contract award, the Subcontractor will be furnished Purchaser-prepared pertinent building, structural steel, electrical tray, lighting, piping composite, and area drawings as they are developed, updated, or revised. The Subcontractor shall develop and update the fire suppression system design and drawings as

required to accommodate the plant design indicated by the Purchaser's drawings, including subsequent changes made by the Purchaser as work progresses.

2-1.03.01. Piping Arrangement. The Subcontractor's piping arrangement shall take into consideration and provide for such adjustment as may be required to avoid interference with the separately specified piping and equipment as indicated on the originally submitted drawings and subsequent revised drawings thereafter.

Automatic or manual fire protection valves shall be located in the areas indicated on the drawings. The Subcontractor's piping configuration shall be such that water hammer forces are at acceptable levels not to rupture the piping during expected operation of the systems. When requested, calculations shall be provided by Subcontractor to verify that water hammer forces were taken into account in the design provided.

Prior to installation, the Subcontractor's piping arrangement, and design data shall be submitted to the Purchaser for review and acceptance in accordance with the submittal requirements.

The Subcontractor shall revise and reroute piping if interferences are discovered either by the Purchaser or in the field during installation. Review of Subcontractor-furnished designs does not indicate a thorough review of all dimensions, quantities, and details of the equipment, materials, devices or items indicated or the accuracy of the information submitted; nor shall review by the Purchaser be construed as relieving the Subcontractor from any responsibility for errors or deviations from the requirements of the contract documents.

The Subcontractor's piping shall be arranged with adequate slope and valved vents and drains so as to be completely drainable.

The Subcontractor shall furnish all piping, pipe supports, valves, and fittings required for complete fire protection systems in compliance with code and these specifications.

Field joint locations and configuration of the section shall be selected with consideration given to field erection problems. Wherever possible, field joints shall be placed in convenient locations. Locations of field joints shall be acceptable to the Purchaser.

The external surface of all black steel piping and all exposed components of shop fabricated piping supports shall be given one coat of primer.

2-1.04. Fire Water Supply. The fire protection water supply system will be furnished and installed by the Purchaser under separate specifications.

The Subcontractor must perform water flow test of the potable water supply system to be used as water supply for the fire protection system scoped for this Section. The Subcontractor must design the fire suppression system based on the test data to meet flow and pressure requirement for the fire protection system per applicable standards.

The Subcontractor shall provide wall type post indicator valve at the water supply connection inside the Building; the water supply connection will be provided by Others. All penetrations through the wall assembly for installation of wall type post indicator valve shall maintain fire resistance rating of the wall using listed material.

2-1.05. Design Requirements. The following design requirements apply to the design of fire suppression systems.

2-1.05.01. Qualifications. The fire suppression systems shall be designed by or under the direct supervision of a registered professional engineer qualified to practice fire protection engineering in California. Such qualification shall be evidenced by either of the following:

Having successfully passed a professional engineering license examination in the discipline of fire protection engineering.

Holding the qualification of Member Grade in the Society of Fire Protection Engineers.

All drawings shall bear the seal of said registered professional engineer. All calculations or submittals other than drawings shall be submitted as securely bound documents and shall also bear the seal of said registered professional engineer.

2-1.05.02. Location. Each system shall be located and shall provide coverage of areas as indicated on the drawings and per applicable federal, state, and local codes.

2-1.05.03. Environment. Each system shall take into account the site location, temperature, seismic, and environmental conditions.

Exterior piping, equipment, and enclosures subject to wind loading shall be designed to resist the wind loads specified in the project site characteristics section.

2-1.05.04. Design Parameters. The Subcontractor shall design each sprinkler and spray system to meet or exceed the requirements of these specifications and the required codes and standards. Each system shall be designed for the specific hazard and shall have UL- or FM-approved equipment and devices.

Special emphasis shall be given to the design of the fire suppression systems to prevent water supply and sprinkler piping and nozzles from interfering with required plant repairs or routine maintenance.

Valves installed between water supply and the fire suppression system shall be supervised and provided with tamper switches. Where required, sprinklers shall be included under obstructions or concealed spaces.

Maximum water velocity in sprinkler and spray system piping shall be 20 ft/s (6 m/s).

The Subcontractor shall verify that the physical locations of automatic or manual valves with respect to the proximity and elevation of the branches are acceptable to avoid hydraulic shock when the valves are actuated.

All components in fire protection systems shall be able to operate at 175 psig (1207 kPag), or at a higher design pressure if indicated within this document or on Purchaser's drawings or if Subcontractor's flow test shows higher.

2-1.06. System Types. The following are various types of sprinkler and spray systems that can be selected. Each system can be designed for manual or automatic activation as allowed per codes. The suppression type selected has been determined to be the most effective method of protection for that hazard:

Sprinkler Systems
Wet-pipe

A permanently attached placard shall be provided on each valve station indicating the location and all hydraulic information as required by NFPA 13.

2-1.06.01. Not used.

2-1.06.02. Not used.

2-1.06.03. Not used.

2-1.06.04. Minimum Wet-pipe Sprinkler Systems. Each wet-pipe sprinkler system shall be designed to provide the minimum coverage density stated in this Section. The wet-pipe sprinkler systems shall be in accordance with the following requirements:

Trouble horn and fire alarm bell shall operate on low voltage dc.

The following equipment shall be provided for each wet-pipe sprinkler system:

Isolation gate valve with tamper switch.

One minimum 4 inch (100 mm) FDC in accordance with NFPA 13, and local requirements complete with check valve, automatic drip, siamese connection, and caps [for each system exceeding 2,000 ft^2 (609.6 m^2)]. Only one FDC required per header.

Strainer (one per header).

Alarm check valve with retard chamber and trim (flow switches are acceptable on systems with 6 heads or less).

Paddle type flow switches in each cross main, for multizone systems only.

Fixed piping system with all necessary pipe, fittings, sprinkler heads, and pipe supports.

Drains and other appurtenances required, including drain piping and isolation valves from system equipment including strainers. Drains and drain piping terminated 12 inches (300 mm) above grade unless specified otherwise.

Inspector's test connection(s) at the end of most remote branch for each flow switch zone.

Trouble alarm horn and fire alarm bell (to be connected with fire alarm system provided by Section 16723)

Minimum system design parameters and sizing requirements as indicated shall be met by wet-pipe sprinkler systems.

2-1.07. Manufacturing and Material Requirements. Manufacturing and material requirements shall be specified herein.

2-1.07.01. Sprinkler and Spray Fittings. Fittings such as tees, coupling, crosses, elbows, cap, and reducers shall be used for changes in direction, intersections, size changes, and end closures of piping. Bushings or similar fittings are not acceptable.

2-1.07.02. Flanges. Welded or threaded steel flanges shall be provided at sprinkler riser branches, valves, and strainers. Flanges welded to galvanized pipe shall be hot-dip galvanized following welding.

Flanges, fittings, and valves manufactured in the People's Republic of China shall meet following requirements as specified in Q400.

2-1.07.03. Strainers. An FM-approved strainer shall be furnished for the main water supply to each system or set of systems. Strainer shall be of the pipeline, self-cleaning type, complete with blowoff valves and flanged ends.

2-1.07.04. Gate Valves. Water supply gate valves shall be of the OS&Y type with flanged ends. All system isolation and header isolation valves shall be furnished with tamper switches wired to the Local control panel.

2-1.07.05. Water Supply Control Valves. Indicator post shall be wall type with cast-iron body, windows for target plates that indicate valve position, extension rod and coupling, locking device, hand wheel operator, wall flange, and red enamel finish shall be furnished. Gate valve for use with wall indicator posts shall be provided with flanged ends and electric tamper switch rated for outdoor conditions.

2-1.07.06. Alarm Check Valves. Alarm check valves shall be installed complete with trim including retard chambers. Each valve shall have a pressure switch to indicate system actuation.

The alarm pressure switch shall have an adjustable range of 2 to 20 psi (0.1 to 1.4 bar) with differential of plus or minus 2 psi (0.1 bar).

2-1.07.07. Backflow Preventer. Install backflow preventer upstream of sprinkler system valve station to prevent back flow of fire water into municipal water supply. Backflow prevent assembly shall use OS&Y gate valve for check valve isolation and provided with tamper switches to be connected and monitored by fire alarm system control panel. Backflow preventer assembly shall meet local water municipality and AHJ requirements.

2-1.07.08. Not used.

2-1.07.09. Not used.

2-1.07.10. Sprinklers. Sprinklers shall be the ½ inch thermosensitive type, UL-listed for the intended service. Temperature ratings are specified on the Section 13930.4.

2-1.07.11. Not used.

2-1.07.12. Not used.

2-1.07.13. Water Shields. Every closed sprinkler head and every pilot head which are not installed close to a solid flat ceiling or which are subject to

impingement from other nozzles or heads shall have a water shield attached. This includes, but is not limited to, pilot heads installed outside and all sprinkler heads installed under grating floors.

2-1.07.14. Plugs. Sprinkler system plugs shall have square heads and shall be of a metal dissimilar to the fitting to which they are attached.

2-1.07.15. Piping Supports. The Subcontractor shall furnish and install all required supports for piping erected under these specifications. The term "piping supports" includes all assemblies such as hangers, floor stands, anchors, brackets, and any supplementary steel required to attach piping supports. All pipe supports shall meet the minimum requirements of NFPA 13.

Centering type beam clamps shall be used instead of end clamps for all piping 2 inches (50 mm) and above.

2-1.07.16. Fire Department Connections. Fire department connections (FDC) shall be double-clapper, siamese type, FM-approved for sprinkler systems, with two 2-1/2 inch (63.5 mm) connections and internal swivel fittings having National Hose Standard threads. Branding or wall plate shall be provided in accordance with NFPA 13. FDC locations shall be as shown on Purchaser's drawings and shall be accessible from outside the structure.

2-1.08. Inspection and Testing. Inspection and testing of the fabricated piping assemblies and piping base materials shall be as stated herein. Documentation of these inspections and tests shall be maintained and supplied to Purchaser. Defects found by these inspections and tests shall be re-inspected following repair by the same method and technique which originally identified the defect. Acceptance shall be based on identical acceptance criteria. Inspection and tests shall be in accordance with NFPA and as stated herein.

2-1.08.01. Hydrostatic Tests. Testing shall be performed on all water system piping and valves in accordance with NFPA 13. Each test shall be conducted for 2 hours at 200 psi (13.9 bar) or at 50 psi (3.5 bar) above the maximum static pressure, whichever is greater. The systems shall be visually inspected during the tests. There shall be no visible leakage or drop in gauge pressure during the tests.

The valves shall be tested along with the piping. Any blind flanges or removable plugs required for openings not closed by the valves and piping provided shall be furnished.

The pressurization equipment including water piping from the supply shall be furnished by the Subcontractor.

Any water remaining in piping after testing shall be protected from freezing until the system is placed into service.

2-1.08.02. Not used.

2-1.08.03. Flow Tests. Each water-based suppression system shall be flow tested.

Flow through the wet pipe systems shall be monitored at the inspector's test connection to verify adequate flow, proper alarm, and annunciation. Systems shall be tested in accordance with the manufacturer's recommendations and to verify proper alarm and annunciation.

The results of these tests shall be recorded and submitted with the Subcontractor's Materials and Test Certificate.

2-1.08.04. Not used.

2-1.09. Welds. Welding methods that comply with all of the requirements of AWS D10.9 (Specification for Qualification of Welding Procedures and Welders for Piping and Tubing), to be used.

Level AR-3, are acceptable means of joining fire protection piping. Welds shall be inspected visually. This inspection shall assure that all welds are free of defects and comply with acceptable conditions as defined in NFPA 13, Figure A.6.5.2.4.1. This visual inspection shall also assure that all the requirements of these contract documents have been met. Personnel performing visual inspection of welds shall be qualified and certified as a Certified Welding Inspector (CWI) in accordance with AWS D10.9, Level AR-3, Standard for Qualification and Certification of Welding Inspector.

Holes in piping for outlets shall be cut to the full inside diameter of the fittings prior to the fittings being welded in place.

Disks shall be retrieved.

Openings cut into piping shall be smooth bore, and all internal slag and welding residue shall be removed.

Fittings shall not penetrate the internal diameter of the piping.

Steel plates shall not be welded to the ends of piping or fittings.

Fittings shall not be modified.

Nuts, clips, eye rods, angle brackets, or other fasteners shall not be welded to pipe or fittings.

Welders or welding machine operators shall, upon completion of each weld, stamp an imprint of their identification into the side of the pipe adjacent to the weld.

2-1.10. Protection During Shipment. Open ends and branches of shop fabricated pipe shall be securely closed to protect the interior cleanliness and end surfaces during shipment.

Weld ends larger than 2 inches (50 mm) shall be protected with suitable metal caps that have ends lined with 3/4 inch (19 mm) soft wood. The caps shall be securely attached and sealed with waterproof tape.

Nonflanged openings 2 inches (50 mm) and smaller shall be protected as follows:

> Female openings, such as sockolets, shall be sealed using pressed-in light metal inserts retained with a seal of waterproof tape.
>
> Nipples shall be sealed with light metal cap retained with a seal of waterproof tape.

Flanged openings shall be sealed with waterproof disks at least 1/2 inch (13 mm) thick bolted to the flange. A 1/8 inch (3 mm) thick rubber gasket shall be provided for sealing. Bolts used for securing the disk shall be a least 1/2 inch (13 mm) diameter, and at least one-half the required bolting shall be used.

Miscellaneous loose items shall be suitably packed in heavy wooden boxes with waterproof linings.

PART 3 - EXECUTION

Erection and installation of fire protection systems equipment and piping shall be in accordance with the requirements of the environmental criteria in the front end sections of this document.

13930.4 Minimum Fire Protection Systems Specification Sheets

General Data	
Subcontractor's scope	
Engineer	Yes

Furnish	Yes
Construct	Yes
Type of system(s) required	
Sprinkler	Yes
Detection	No
Suppression/Detection Systems	
Wet-Pipe Sprinkler	
System designation	
Area or equipment protected	Operations Building
Detection or actuation device	Thermosensitive sprinkler heads [rated at 175° F(79° C)]
Notification device	Electric Bell
Coverage density	0.1 gpm/sqft over 1,500 sqft
Wet-Pipe Sprinkler	
System designation	
Area or equipment protected	Maintenance Building
Detection or actuation device	Thermosensitive sprinkler heads [rated at 175° F(79° C)]
Notification device	Electric Bell
Coverage density	0.2 gpm/sqft over 1,500 sqft

End of Section

Section 22 00 00

PLUMBING

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of materials, appliances, fixtures, equipment, and appurtenances associated with the plumbing systems as specified herein and as indicated on the Drawings. Additional requirements for plumbing systems shall be as indicated in the schedules on the Drawings. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

Pipe materials, valves, thermal insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1-2. GENERAL. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. Not used.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall conform to the requirements of AGA, ASTM, NFPA, and UL safety requirements.

1-2.05. Power Supply. Unless otherwise specified, power supply to equipment with motors shall be as indicated on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1-2.06. Metal Thickness. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Equipment, Piping Accessories, and Appurtenances
- Name of manufacturer.
- Type and model.
- Construction materials, thicknesses, and finishes.
- Capacities.
- Pressure and temperature ratings.
- Overall dimensions.
- Piping connection sizes and locations.
- Net weight.
- Horsepower [kW].
- Power requirements.
- Wiring diagrams.

Plumbing Fixtures
- Name of manufacturer.
- Type and model.
- Construction materials, thicknesses, and finishes.
- Water consumption data.
- Overall dimensions.
- Rough-in dimensions.
- Piping connection sizes and locations.
- Net weight.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operations and Maintenance Data and Manuals. { .}{Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

Operation and maintenance manuals are required for water closets, urinals, faucets and flush valves, emergency fixtures, electric water coolers, water heaters, circulating pumps, hose reels, and expansion tanks.

1-4. QUALITY ASSURANCE.

1-4.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1-4.02. Qualification. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

1-4.03. Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1-4.04. Construction. Plumbing fixtures shall be constructed in accordance with the following standards:

Enameled Cast Iron	ANSI/ASME A112.19.1M
Vitreous China	ANSI/ASME A112.19.2M
Stainless Steel	ANSI/ASME A112.19.3M
Faucets	ANSI/NSF 61
Emergency/Safety Fixtures	ANSI Z358.1

Electric water coolers shall be UL listed and certified in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 1010. All materials in contact with water shall comply with the Reduction of Lead in Drinking Water Act. All plumbing fittings and fixtures intended to convey or dispense water for human consumption shall comply with the requirements of NSF/ANSI 61 and NSF/ANSI 372 for lead-free.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the recommendations and this Section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for each type and size of plumbing fixture or equipment as required, in the quantities indicated below.

Part	Number Required
Flushometer valve repair kits	1 per 5 fixtures
Faucet washer cartridge and O-ring kits	1 per 5 fixtures

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All plumbing fixtures and equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the Drawings.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the contract Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MANUFACTURE AND FABRICATION.

2-4.01. Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage In Concrete and Masonry section unless otherwise indicated on the Drawings.

2-4.02. Surface Preparation. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2-4.03. Shop Painting. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the Protective Coatings section.

2-4.04. Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches [150 mm] high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2-4.05. Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2-4.06. Piping Systems. Unless otherwise specified herein, piping system materials shall be as specified in other sections.

2-4.07. Valves. Unless otherwise specified herein, valves indicated to be a part of the plumbing systems shall be as specified in other sections.

2-5. WATER SUPPLY PIPING ACCESSORIES.

2-5.01. Water Hammer Arresters. Water hammer arresters shall be either bellows or piston type. Bellows type arresters shall consist of a stainless steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arresters shall consist of a seamless Type L copper shell, a seamlessly spun and factory

charged air chamber, a factory lubricated double or triple O-ring sealed piston, and a threaded copper adapter. Water hammer arresters shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1010. Arresters shall be rated for a maximum working pressure of 350 psig [2400 kPa gauge] and a temperature range of 33°F to 250°F [1°C to 120°C]. Water hammer arresters shall be Smith "Hydrotrol", Josam "75000 Series Absorbotron", Wade "Shokstop", or Sioux Chief "Hydra-Rester".

2-5.02. Trap Primers.

2-5.02.04. Electronic Trap Priming Panel. Electronic trap priming panels shall be provided as indicated by the plumbing drawings denoted by a symbol “TPP” and an identifying number. One half-inch copper tubes shall run from the electronic trap priming panel to the traps. Trap primers shall be mounted in accessible locations. Electronic trap priming panels shall consist of a panel, timer, 120 V solenoid, calibrated manifold system and shall be manufactured by Precision Plumbing Products Inc. “PTS Series”, Zurn, MIFAB, or equal. Reference the plumbing drawings for the number of priming tubes required per trap priming panel.

2-5.03. Thermostatic Mixing Valves. Thermostatic mixing valves shall comply with ASSE 1017, shall be bronze or brass body, with stainless steel flow control components, threaded end connections, rotating handle adjustment, lockable setpoint, and hot and cold check stops. Valves shall be suitable for flow ranges and have temperature adjustment ranges as indicated in the schedules. Temperature adjustment range shall be 85°F [29 °C] to 120°F [49 °C]. Accuracy shall be within 3°F [2°C] of setpoint. Thermostatic mixing valves shall be manufactured by Symmons, Leonard, or Powers.

2-5.04. Vacuum Relief Valves. Not used.

2-5.05. Thermometers. Thermometers shall be Weksler Instruments "Adjust Angle", Ashcroft "Series EI Everyangle" or Weiss Instruments, Inc. “Vari-angle”.

Thermometers shall be bimetal type and shall have a dial at least 4-1/2 inch [114 mm] diameter, with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

Each indicator shall be furnished with an angularly adjustable frame for convenient viewing. Unless otherwise indicated, thermometer range shall be 0 to 200°F [-10 to 110°C].

Each thermometer shall be furnished with a stainless steel thermowell for installation in the piping systems. The thermowells shall have 3/4 inch [20 mm] NPT thread mounts, a minimum pressure rating of 250 psig [1725 kPa gauge], and a nominal 4 inch [100 mm] insertion length.

2-5.06. Strainers. Strainers shall be provided where indicated on the Drawings. Strainer screen size shall be 20 mesh unless otherwise indicated. The blowoff from each strainer shall be equipped with a shutoff valve.

Strainers located in copper piping systems shall be Y-pattern type with bronze body, threaded ends, and monel or stainless steel screens. Strainers shall be Watts “Series LF777SI”, Apollo Valves “Model YB-LF” or Wilkins “Model YBXL”.

Strainers located in ductile iron piping systems shall be Y-pattern type with iron body, flanged ends, and monel or stainless steel screens. Strainers shall be Hoffman Specialty “Series 400” or Metraflex “Model TF”.

2-5.07. Hose Faucets. Hose faucets shall be constructed with nickel or chrome plated cast brass body, solid brass stem, threaded bonnet, and “T” style handle. Hose faucets shall be provided with a 3/4 inch male pipe thread inlet and a 3/4 inch male hose thread outlet unless otherwise indicated on the Drawings. Hose faucets shall be Prier Brass “Model C-138NP.75”, Arrowhead Brass Products, or Zurn.

Where indicated on the Drawings, hose faucets shall be equipped with hose connection vacuum breakers. Hose connection vacuum breakers shall be provided with 3/4 inch [19 mm] hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be equipped with manual drain. Hose connection vacuum breakers shall be Febco “Series 731”, Watts Regulator Company “Series 8” or Wilkins “Model BFP 8”.

2-5.08. Hose Valves. Each angle type hose valve shall consist of an angle valve and hose nipple. Angle valves shall be Class 150 angle type with bronze body, PTFE disc, union bonnet, rising stem, and threaded ends. Angle type hose valves shall be Stockham “B-222T”, Milwaukee, or Powell. Hose nipples shall be one piece, cast brass or bronze, with male NPT and male hose thread ends. A cap and chain shall be provided for hose valves in interior locations. Hose nipples shall be Potter-Roemer, Inc. “2830 Series”, Croker Corp., or Elkhart Brass.

Each in-line hose valve shall consist of a straight pattern globe valve. Straight pattern type globe valves shall consist of a brass body with extended valve stem, handwheel, union bonnet, rising stem, and threaded ends. In-line type hose

valves shall be Potter-Roemer, Inc. “4120 Series” or Guardian Fire Equipment, Inc. “5320 Series”.

All hose valves shall be 1-1/2 inch size unless otherwise indicated on the Drawings.

2-5.09. Wall Hydrants. Wall hydrants shall be freezeproof type with bronze body, polished bronze or chrome plated face, integral vacuum breaker, and removable handle key. Wall hydrants shall be provided with ¾ inch pipe thread inlet and ¾ inch male hose thread outlet. Wall hydrants shall be ASSE 1019-B approved. Wall hydrants shall be Smith “Model 5619”, Zurn “Z1321-C”, or Prier “Model C-634”.

2-5.10. Pressure Gauges. Pressure gauges shall be Ashcroft "Duragauge 1279", Weksler, or Weiss Instruments, Inc.

Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade A or better. Gauges shall be indicating dial type with C-type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.

The dial shall be 4-1/2 inch [114 mm] in diameter with black markings on a white background. The units of measurement shall be psi and shall be indicated on the dial face. The pointer shall span not less than 200 degrees nor more than 270 degrees. The range shall be selected so that the normal operating reading is near the midpoint of the scale.

Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Ball Valves section.

All stem-mounted gauges shall be provided with 1/2 inch [13 mm] NPT connections.

2-5.10.01. Diaphragm Seals. Pipe-mounted diaphragm seals shall be provided where indicated on the Drawings. Diaphragm seals shall be thread-attached type with cleanout ANSI Type 316 stainless steel diaphragm, plated carbon steel upper housing, and stainless steel lower housing. The diaphragm seal shall be of “continuous” design to safely contain the process fluid in the event of gauge failure or removal from the system under pressure. The lower housing shall be provided with a tapped ¼ inch [6.3 mm] NPT flushing connection and an MxF stainless steel needle valve. Each gauge isolator and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

Gauge isolators shall be as manufactured by Ashcroft “Type 101”, Weksler, or Weiss Instruments, Inc.

2-6. DRAINAGE AND VENT PIPING ACCESSORIES.

2-6.01. Cleanouts. Cleanouts shall be provided where indicated on the Drawings and required by the referenced codes, and shall be of the required type.

Floor cleanouts shall consist of a two piece body, a threaded plug, an adjustable head, and a cover. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanout covers shall be stainless steel. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T-pattern, 90 degree drainage fitting.

Cast iron cleanouts shall be manufactured by Smith, Josam, or Wade. Polypropylene cleanouts shall be manufactured by Orion, Enfield, or Zurn. PVC cleanouts shall be manufactured by Sioux Chief, Plastic Oddities, or Zurn.

2-6.02. Bell-Up Drains. Not used.

2-6.03. Funnel Receptors. Funnel receptors shall consist of cast iron funnels with cast iron dome type bottom strainers. Funnel receptors shall be provided with waterstop flange and threaded or no-hub outlet connections suitable for connection to the waste piping. Funnel receptors connected to chemical resistant waste systems shall be furnished with a factory applied chemical resistant interior coating. Unless otherwise indicated, funnel receptors shall be installed 1 inch [25 mm] above the finished floor.

Funnel receptors shall be Smith “Series 3800 Figure SQ-3-1793-DBS”, Josam, or Wade.

2-6.04. Floor Drains. Floor drains shall be of the types specified herein and indicated on the Drawings. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the Drawings. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.

Cast iron floor drains shall be manufactured by Smith, Josam, or Wade. Polypropylene floor drains shall be manufactured by Orion, Enfield, Zurn. PVC floor drains shall be manufactured by Sioux Chief, Plastic Oddities, or Zurn.

2-6.05. Roof Drains and Overflow Roof Drains. Not used.

2-6.06. Downspout Nozzles. Not used.

2-6.07. Modular Trench Drain System. Not used.

2-6.08. Floor Sinks. Floor sinks shall consist of a cast iron body with acid resistant interior finish, and a nickel-bronze grate. The grate shall be of the type indicated on the Drawings shall be easily removable for cleaning. Floor sink grates and outlets shall be sized as indicated on the Drawings. Floor sinks shall be manufactured by Smith, Josam, or Wade.

2-6.09. Backwater Valves. Not used.

2-6.10. Vent Flashings. Plumbing vent flashings shall be furnished and installed as indicated on the Drawings.

2-7. PLUMBING FIXTURES AND ACCESSORIES.

2-7.01. General. Plumbing fixtures shall be provided with all required supports, fasteners, supply and drain fittings, gaskets, and escutcheons required for a complete installation.

2-7.02. Water Closets. Water closets shall be of vitreous china, with an elongated bowl and siphon jet flushing action. The type and water use of water closets shall be as indicated on the Drawings. All water closets shall be provided with anchor bolt caps. Flush valve type water closets shall be provided with top spud connections for flushometer valves. Flush tank type water closets shall be provided with factory installed tank liners. Field installed liner kits will not be acceptable. Water closets shall be manufactured by American Standard, Kohler, or Eljer.

2-7.02.01. Seats. Water closet seats shall be white, solid plastic, contoured, elongated open front type without cover, with concealed check and stainless steel hinges. The seats shall be manufactured by American Standard, Kohler, Eljer, or Church.

2-7.02.02. Flush Valves. Flush valves for top spud type water closets shall be exposed type, with a chrome plated brass body, an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, and a 1 inch [25 mm] NPT water supply connection. Flush valves shall be Sloan "Royal 111", Delaney, or Zurn.

2-7.02.03. Supply Set. A supply set consisting of a 1/2 inch [13 mm] NPT brass angle loose key stop valve, a copper supply tube, and an escutcheon plate shall be furnished for each tank type water closet. All supply components shall be polished chrome.

2-7.02.04. Chair Carriers. Wall-mounted water closets shall be provided with adjustable chair carriers. The carriers shall be suitable for the chase depth and piping arrangement and shall consist of a heavy-duty cast iron body, complete

with a drainage fitting, pylon feet, a drainage nipple, fitting and fixture gaskets, a positioning frame or template, and mounting hardware. Chair carriers shall be manufactured by Smith, Josam, or Wade.

2-7.03. Urinals. Urinals shall be of the type and water use as indicated on the Drawings. Urinals shall be of vitreous china, wall mounted, with an elongated rim and washout flushing action, and shall be provided with a top spud connection for a flushometer valve. Urinals shall be manufactured by American Standard, Kohler, or Eljer.

2-7.03.01. Flush Valves. Flush valves shall be exposed type, of chrome plated brass with an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, and a 3/4 inch [19 mm] NPT water supply connections. Flush valves shall supply a maximum of 1 gallon [3.8 L] per flush, and shall be Sloan "Royal 186", Delaney, or Zurn.

2-7.03.02. Supports. A fixture support system, including support legs, upper and lower bearing plates, and bearing studs shall be provided for urinals mounted on all walls other than masonry. Urinals mounted on masonry walls shall be provided with suitable anchor bolts. Urinal supports shall be manufactured by Smith, Josam, or Wade.

2-7.04. Lavatories. Lavatory types, dimensions, and water use shall be as indicated on the Drawings. Lavatories shall be of vitreous china, constructed with overflow drains and soap depressions. Countertop lavatories shall be self-rimming, and shall be provided with suitable adhesive and/or fastening clamps. Wall-mounted lavatories shall be drilled for a concealed arm carrier. Faucet drillings shall be 4 inches [100 mm] on center unless otherwise indicated. Lavatories shall be manufactured by American Standard, Kohler, or Eljer.

2-7.04.01. Faucets and Trim. Lavatory faucets shall be 4 inches [100 mm] on center, of polished chrome, with a vandal-resistant single-lever handle and all-brass or copper waterways. Each faucet shall be provided with a flow restrictor, a cast brass grid strainer or pop-up drain as indicated on the Drawings, and a 1-1/4 inch [32 mm] cast brass tailpiece. Flow restrictors shall limit water flow as required by the applicable codes and standards. Supply sets consisting of 1/2 inch [12.5 mm] NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be furnished for each lavatory faucet. All supply components shall be polished chrome. Where indicated to be ADA compliant and exposed to human contact, lavatory supplies shall be insulated. Lavatory faucets and supply sets shall be manufactured by American Standard, Kohler, or Eljer.

2-7.04.02. Traps. Lavatory traps shall be at least 1-1/4 inches [32 mm] in diameter, cast brass with polished chrome finish, with an escutcheon flange and a cleanout plug. Where indicated to be ADA compliant and if exposed to human contact, lavatory traps shall be offset, insulated type.

When insulation is needed, lavatory supplies and traps may be pre-insulated or furnished with an insulation kit for field installation. Insulating material shall be flame retardant closed cell vinyl. The supply insulating kit shall be snap form type or shall be provided with ties. The trap insulation material shall not require the use of ties or mechanical fasteners to be held in place. Pre-insulated traps and supply insulation kits shall be McGuire Products "ProWrap". Trap and supply insulation kits shall be as manufactured by IPS Corporation-Truebro, Plumberex, or Buckaroos, Inc.

2-7.04.03. Supports. Wall-hung lavatories shall be provided with a complete fixture support system, including support legs, bearing plates, concealed arms, and anchor bolts. The support legs shall be mounted within the partition wall. For lavatories mounted on masonry walls, support legs may be omitted. Lavatory supports shall be manufactured by Smith, Josam, or Wade.

2-7.05. Showers. Shower type, dimensions, and water use shall be as indicated on the Drawings.

2-7.05.01. Built-up Shower Stalls. Each built-up shower stall shall be provided with a pressure-balanced single lever mixing valve, a shower head, an arm, and a flange. The shower valve shall include integral service stops and an adjustable stop screw. The shower head shall be of adjustable spray pattern type, with volume control, a swivel ball joint, and an integral flow control device. ADA compliant units shall include a hand-held shower head with swivel fitting, a 69 inch [1.7 m] stainless steel flexible hose, a support rod, and an in-line vacuum breaker. All exposed components shall be polished chrome.

2-7.05.02. Prefabricated Shower Modules, ADA Compliant. Not used.

2-7.05.03. Prefabricated Shower Modules. Not used.

2-7.06. Stainless Steel Sinks. Sink types, dimensions, hole punching, metal gage, and water use shall be as indicated on the Drawings.

Stainless steel sinks shall be seamless Type 304 stainless steel, with smooth radius interior corners. All exposed surfaces of sinks shall be machine polished to a bright finish and the underside shall be fully undercoated. Countertop mounted sinks shall be self-rimming with compartment and faucet deck recessed below the outer edge of the sink. Sinks shall be provided with mounting clips, support legs, and all other hardware as indicated in the schedules. Stainless steel sinks shall be manufactured by Elkay, Just, or Advance Tabco.

2-7.06.01. Faucets. Sink faucets shall be polished chrome, with a vandal-resistant single-lever handle. All waterways shall be constructed of brass or copper. Faucets shall be provided with a brass spout, an aerator, and a flow restrictor. Supply sets consisting of 1/2 inch [12.5 mm] NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be provided. All supply components shall be polished chrome. Sink faucets and supply sets shall be manufactured by American Standard, Kohler, or Eljer.

2-7.06.02. Drain Assembly. All required drainage accessories, including strainers, tailpieces, and traps, shall be provided. Basket strainers shall be heavy gage stainless steel, with a removable conical strainer plate and a neoprene stopper. Tailpieces shall be chrome plated brass. Sink traps shall be at least 1-1/2 inches [38 mm] in diameter, cast brass, with polished chrome finish, an escutcheon flange, and a cleanout plug.

2-7.07. Janitors Sinks. Janitors sink types, dimensions, manufacturers, and models shall be as indicated on the Drawings.

Mop sinks shall be floor mounted and constructed of pearl gray terrazzo. Mop sinks shall be provided with an integral 20 gage [0.91 mm] thick stainless steel threshold cap, a 6 inch [150 mm] drop at threshold, and a shoulder at least 1-1/4 inches [32 mm] wide. A 3 inch [75 mm] cast brass drain and stainless steel strainer, and where indicated, a 20 gage [0.91 mm] thick stainless steel splash panel shall be provided for each sink. Mop sinks shall be manufactured by Stern-Williams, Fiat, or Florestone Products Company, Inc.

2-7.07.01. Faucets. Sink faucets shall be rough plated brass, with lever handles, a threaded spout, a vacuum breaker, a wall brace, and a pail hook. The distance from the wall to the center of the spout outlet shall measure approximately 7-1/2 inches [190 mm]. Sink faucets shall be as manufactured by American Standard, Kohler, or Eljer.

2-7.07.02. Drain Assembly. Mop sinks shall be provided with a 3 inch [75 mm] cast brass drain and a stainless steel strainer. Service sinks shall be provided with a 3 inch [75 mm] cast iron P-type trap standard, with a stainless steel strainer, a cleanout plug, and a threaded outlet.

2-7.08. Emergency Fixtures. Emergency fixtures, including showers, eye/face washes, and combination shower/eye/face wash units shall be furnished and installed as indicated on the Drawings. Emergency fixtures shall be manufactured by Haws, Guardian, or Encon.

2-7.08.01. Indoor Emergency Eyewash Fixtures. Indoor emergency eyewash fixtures shall be pedestal mounted or wall mounted as indicated on the Drawings. Eyewash fixtures shall be provided with a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, and a universal emergency sign. Wall mounted units shall also be provided with a wall bracket and a chrome

plated trap. All necessary accessories required for a complete installation shall be provided.

2-7.08.02. Indoor Emergency Shower Fixtures. Not used.

2-7.08.03. Indoor Combination Units. Combination emergency shower/eye/face wash fixtures shall be pedestal mounted, with a stanchion, a floor flange, a deluge shower, an aerated eye/face wash, an eye/face wash dust cover, stay-open ball valves, interconnecting piping, and a universal emergency sign. The shower shall be stainless steel or ABS plastic with a stainless steel pull rod actuator. The eye/face wash receptor shall be stainless steel with push plate and foot pedal actuators.

2-7.08.04. Corrosion Resistant Combination Units. Not used.

2-7.08.05. Freezeproof Emergency Eyewash Fixtures. Not used.

2-7.08.06. Freezeproof Emergency Shower Fixtures. Not used.

2-7.08.07. Freezeproof Combination Units. Freezeproof combination emergency shower/eyewash fixtures shall be pedestal mounted, with a stanchion, a floor flange, a deluge shower, an aerated eye/face washes, freezeproof stay-open valves, interconnecting piping, freeze protection bleed valve, scald protection bleed valve, and a universal emergency sign. The shower and eye/face wash shall be stainless steel or ABS plastic with a stainless steel actuator. The entire unit shall be provided with self-regulating heating cable and shall be insulated with polyethylene foam insulation. The insulation shall be provided with a removable, UV resistant, ABS plastic jacket with gasketing and removable fasteners. Electric heating cable shall be suitable for the outdoor temperature and power supply indicated on the Drawings.

2-7.08.08. Alarm Systems. An audible and visual alarm system shall be provided when indicated on the Drawings. The alarm system shall activate based on water flow when either the emergency shower or eyewash fixture is operated. The alarm system shall provide local, remote, or local and remote alarm indication as indicated on the Drawings. The water flow switch shall be provided with double-pole double-throw contacts rated 5 amperes at 125 volts, suitable for remote alarm annunciation. The audible alarm shall provide an intermittent signal rated at 90 dB at 10 feet. The alarm light shall be amber, flashing type. The alarm system shall be pre-wired and shall be furnished with all necessary junction boxes, conduit, wire, and accessories for a complete installation. The alarm system shall be suitable for a 120 volt power supply.

2-7.08.09. Tempered Water Blending Valves. Tempered water blending valves shall be designed specifically for providing tempered water to emergency shower and eyewash fixtures. Each valve shall contain thermostatic elements, integral

cold water bypass, and positive hot water shutoff to prevent scalding. Blending valves shall have bronze or brass bodies with threaded inlet and outlet connections and shall be provided with isolation check valves on the hot and cold supplies to the unit. Each unit shall include hot, cold, and blended water temperature gauges and shall be factory set for a blended water temperature of 70°F.

Tempered water blending valves serving eyewash fixtures, a single shower, or a single combination unit shall be suitable for a flow range of 3 to 25 gallons per minute [0.2 L/s to 1.9 L/s] and shall be Haws “Model 9201”, Guardian”G3700”, or Lawler “Model 911E. Tempered water blending valves serving multiple showers or multiple combination units shall be suitable for a flow range of 3 to 60 gallons per minute [0.2 L/s to 4.5 L/s] and shall be Haws “Model 9202”, Guardian “G3900” or Lawler “Model 911”.

2-7.08.10. Scald Protection Valves. Scald protection valves shall be designed specifically for providing scald protection to emergency shower and eyewash fixtures. Each valve shall be constructed of a one piece bronze or brass body with threaded inlet and outlet connections, and shall contain a removable cartridge for cleaning and maintenance, automatic thermal actuator bleed valve that opens when water temperature exceeds 95° F and closes when the water temperature falls below 87° F. Scald protection valves shall be as manufactured by Haws “Model SP157B”, Guardian or Encon.

2-7.08.11. Electric Instantaneous Emergency Fixture Water Heaters. Instantaneous water heaters shall be industrial tankless type designed specifically for emergency shower/eyewash tempered water service, and shall heat water on demand as determined by an integral flow switch. Heaters shall be suitable for operating water pressures of 25 to 150 psig [14 to 1034 kPa gauge]. Heater waterways shall be of brass/copper construction. If required by applicable codes, each heater shall be provided with a temperature and pressure relief valve. Heaters shall be provided with thermostatic control, internal fusing, 100 degree thermal cut off fuses, and digital temperature control. Provide LED controller with dual display of set point and actual temperature with set point temperature locked out to a specified range. Provide fully modulating PID temperature control with a +/- 1 degree F accuracy on regulated pressure, external emergency stop button, and NEMA 4enclosures. Provide factory floor stand kit for free standing installation. Electric instantaneous water heaters shall be UL listed and shall be manufactured by Keltech SN Safety Shower Series.

2-7.09. Wash Fountains. Not used.

2-7.10. Electric Water Coolers. Electric water cooler type, capacity, manufacturer, and model shall be as indicated on the Drawings. Water coolers shall be wall mounted, mechanically refrigerated type, and shall deliver 50°F [10°C] water at the specified rate, based on 80°F [27°C] inlet water temperature

and a room temperature of 90°F [32°C]. The water coolers shall consist of a heavy gage steel cabinet, an insulated cooling tank, a stainless steel receptor, copper water lines, a water pressure regulating valve, an adjustable thermostat, and a 3-wire power cord with a polarized plug. The refrigeration unit shall consist of a hermetically sealed spring mounted compressor and an air-cooled condenser. Electric water coolers shall be suitable for a 120 volt, 60 Hz, single phase power supply, shall be UL and ARI listed, and shall be manufactured by Elkay, Oasis, or Halsey Taylor.

2-7.11. Food Waste Disposers. Not used.

2-8. PLUMBING EQUIPMENT.

2-8.01. General. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

2-8.02. Water Heaters and Accessories. Water heaters shall be furnished and installed where indicated on the Drawings. Heater type, storage capacity, recovery rate, energy input, power supply requirements, manufacturer, and model shall be as indicated on the Drawings.

2-8.02.01. Commercial Grade Electric Storage Water Heaters. Not used.

2-8.02.02. Industrial Grade Electric Storage Water Heaters. Not used.

2-8.02.03. Electric Instantaneous Water Heaters. Not used.

2-8.02.04. Commercial Grade Gas-Fired Water Heaters. Gas-fired water heaters shall be commercial, storage type, with a glass-lined tank and a natural or propane gas burner as indicated on the Drawings. Heaters shall be provided with a cold water inlet tube, a magnesium anode, high density fiberglass insulation, a drain valve, a flue damper, and an adjustable thermostat. The heater burner shall be atmospheric type, constructed of aluminized steel, and shall be suitable for a minimum gas supply pressure as indicated on the Drawings. The burner shall be provided with a gas pressure regulator, a manual reset safety shutoff, and an intermittent electronic ignition control system. Burner operation shall be interlocked with the flue damper to prevent burner and pilot ignition until the flue damper is proven open. Heater tanks shall be ASME stamped for a working pressure of at least 125 psig [862 kPa gauge]. Heater tanks larger than 70 gallons [265 L] shall be provided with an inspection port. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heaters shall be UL, AGA, and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. The water heaters shall be manufactured by State Industries, A. O. Smith, or Lockinvar.

2-8.02.05. Industrial Grade Gas-Fired Water Heaters. Not used.

2-8.02.06. Water Heater Flues. A complete flue system shall be provided for each gas-fired water heater. Unless otherwise required to maintain the listing of the heater, water heaters utilizing atmospheric burners or fan assisted heaters which operate under a negative flue pressure shall be provided with a Type 'B' flue system. Water heaters utilizing forced draft burners which pressurize the flue shall be provided with a pressurized flue system. Metal flues shall be as specified in the Heating, Ventilating, and Air Conditioning sections.

For applications where under normal conditions the flue gas is expected to be condensing in the flue, and when recommended by the water heater manufacturer, flues shall be schedule 40 PVC pipe with drain, waste, vent (DWV) fittings.

2-8.02.07. Circulating Pump. A circulating pump shall be furnished and installed where indicated on the Drawings. Pump capacity, power requirements, manufacturer, and model shall be as indicated on the Drawings.

The circulating pump shall be an in-line unit with a bronze body, bronze fitted, mechanical seals, a stainless steel or ceramic shaft, and at least 1/2 inch [13 mm] NPT connections. The circulating pump shall be controlled by a 7-day time clock provided with the pump. Initial time clock setting shall energize the pump at 6:00 am and de-energize the pump at 6:00 pm each day. The time clock shall be suitable for a 120 volt single phase power supply, and shall have contacts rated for 10 amperes ac. The circulating pump shall be manufactured by Bell & Gossett, Thrush, or Taco.

2-8.03. Neutralization Tanks. Neutralization tank volume, connection sizes, manufacturer, and model shall be as indicated on the Drawings.

Neutralization tanks shall be of heavy-duty construction, rotomolded in one piece from polyethylene resins. Inlet, outlet, and vent fittings molded from the same resins as the tank shall be triple-welded to the tank body at the locations indicated on the Drawings. A full diameter extension constructed of the same material as the tank shall be provided where required to raise the access cover to at or just below the floor level as indicated on the Drawings. When indicated on the Drawings, the tank shall be provided with a minimum 17 inch [430 mm] bolted manway cover. The cover shall be provided with a 6 inch [150 mm] cleanout plug and stainless steel fasteners. The tank shall be filled with hard limestone or marble chunks, 2 to 3 inches [50 to 75 mm] in diameter to the level recommended by the manufacturer. Neutralization tanks shall be manufactured by Enfield, Orion, or Town & Country Plastic, Inc.

2-8.04. Hose Reels. Hose reel type, capacity, manufacturer, and model shall be as indicated on the Drawings.

Each hose reel shall be provided complete with a hose storage drum, a handle crank winding mechanism, a spring-actuated pin lock, and a heavy duty frame suitable for anchoring to concrete or masonry wall or floor supports. Unless indicated on the Drawings to be stainless steel, hose reels shall be carbon steel with a baked epoxy enamel finish. When indicated on the Drawings, hose reels shall be provided with a water supply swivel joint rated at 600 psig [4,130 kPa gauge]. The hose storage drum shall be provided with a brass male hose adapter suitable for use with the specified hose. The hose reels shall be manufactured by Hannay, Potter-Roemer, or Reelcraft.

2-8.05. Hoses. Hose type, diameter, manufacturer, and model shall be as indicated on the Drawings.

Unless otherwise indicated, each hose shall be provided with one male swivel type brass hose connector, one female brass hose connector, and one regulating wash-up spray nozzle. Spray nozzles in 1 inch [25 mm] and 1-1/2 inch [38 mm] sizes shall be Potter-Roemer Inc. "Series 2970" with a cast brass body, a rubber bumper, and a female hose thread.

2-8.05.01. Type 1 Hoses. Type 1 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig [1030 kPa gauge] working pressure. The hose shall consist of 1-1/2 inch [38 mm] ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 1 hoses shall be Gates Rubber Company "Water Master" or Potter-Roemer “Model 2853”.

2-8.05.02. Type 2 Hoses. Type 2 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig [1030 kPa gauge] working pressure. The hose shall consist of 3/4 inch [19 mm] ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 2 hoses shall be Gates Rubber Company "Adapta Flex" or Potter-Roemer “Model 2851”.

2-8.05.03. Type 3 Hoses. Type 3 hoses shall be non-collapsible, suitable for hot water service and shall be rated for 200 psig [1380 kPa gauge] working pressure. The hose shall consist of 1 inch ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. The hose shall have an integrated nozzle. The hose end opposite the nozzle shall be furnished with a female thread brass hose connector with swivel. Type 3 hoses shall be Gates Rubber Company "Creamery/Paper Mill Washdown".

2-8.05.04. Type 4 Hoses. Type 4 hoses shall be suitable for lay flat water discharge service and shall be rated for 75 psig [500 kPa gauge] working pressure. The hose shall be 1-1/2 inch [38 mm] ID with a heavy-duty polyvinyl chloride (PVC) body and synthetic, high tensile textile cord reinforcement. Type 4 hoses shall be Gates Rubber Company "Master-Flex 500".

2-8.06. Interceptors. Not used.

2-8.07. Expansion Tanks. Expansion tank capacities, connections, manufacturer, and model shall be as indicated on the Drawings.

Expansion tanks shall be welded steel diaphragm type, ASME tested and stamped for a working pressure of 125 psig [862 kPa gauge], with a flexible diaphragm and a charging valve. Floor-mounted tanks shall be provided with a suitable mounting base. The tanks shall be suitable for use with potable water and shall be factory pre-charged to the indicated pressure. Expansion tanks shall be manufactured by Amtrol, State Industries Inc., or Watts.

2-8.08. Water Storage Tank. Not used.

2-8.09. Automatic Water Softener Unit. Not used.

2-9. COLOR. Vitreous china, cast iron, enameled steel, and composite plumbing fixtures shall be white unless otherwise indicated. Other plumbing fixtures shall be the manufacturers standard color. Plumbing equipment shall have the manufacturer's standard color and finish unless otherwise indicated in the schedules.

2-10. ELECTRICAL. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3-2. PREPARATION.

3-2.01. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

3-3. INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Unless otherwise indicated, sleeves shall be provided for all pipe penetrations through concrete and masonry walls. Sleeves and sealing requirements shall be as indicated in the Miscellaneous Piping and Accessories Installation section and as indicated on the Drawings.

Not all required reducing fittings and unions are indicated. Additional fittings and unions shall be provided as needed to connect all equipment and appurtenances.

Insulating fittings shall be provided to prevent the contact of dissimilar metals in piping systems.

When located indoors, fuel gas pressure regulator vents and fuel train vent valves shall be piped to the exterior of the building in accordance with the applicable codes and standards.

Piping shall not be routed over or in front of electrical switchboards or panels unless acceptable to Engineer.

3-3.01. Water Supply Piping and Accessories. Water hammer arresters shall be provided in the hot and cold water supply piping at all quick closing valves, at solenoid valves, and at plumbing fixtures. When not indicated on the Drawings, arresters shall be located and sized by Contractor in accordance with PDI Standard No. WH201. Contractor shall submit arrester location and sizing plans to Engineer for approval prior to installation. Where possible, water hammer arresters shall be installed in an accessible location.

Water supply piping to hose faucets and hose valves shall be secured with a pipe support within 6 inches [150 mm] of the fixture.

Scald protection valves shall be installed per manufacturer's recommendation, adjacent to the actuation valve for each emergency shower and the eye/face wash where indicated in the schedules. Drain piping from valves shall be secured to adjacent unit support and routed to nearest funnel receptor and discharge with an air gap.

3-3.02. Drainage and Vent Piping and Accessories. Unless otherwise indicated or required by code, horizontal sanitary drainage piping 3 inches [75 mm] in diameter or smaller shall be installed at a uniform slope of 1/4 inch per foot [2 percent]; horizontal sanitary drainage piping larger than 3 inches [75 mm] in diameter shall be installed at a uniform slope of 1/8 inch per foot [3 mm/300 mm]; horizontal storm drainage piping shall be installed at a uniform slope of 1/8 inch per foot [3 mm/300 mm].

All cast iron drainage piping which is buried beneath floors shall be encased in at least 6 inches [150 mm] of concrete. A joint shall be provided in the piping within 12 inches [300 mm] of each end of the encasement. For buildings supported by piers or piles, the concrete encasement shall be reinforced and connected to the floor slab.

Plastic drainage pipe buried beneath floors shall not be encased. For buildings supported by piers or piles plastic drainage piping which is buried beneath floors shall be supported with stainless steel pipe supports per ASTM F2536.

Drainage fittings shall be installed to convey flow in the piping in the intended direction. To the extent possible, changes in direction shall be made by sweep type fittings. Quarter-bends and sanitary tee fittings shall not be installed for vertical to horizontal or horizontal to horizontal changes of direction.

Plumbing vents through roofs shall be located at least 12 inches [300 mm] from a parapet or from the intersection of a cant with the roof deck, and shall be installed with watertight flashings. Plumbing vents shall be located no closer to operable windows or air intakes than is allowed by the applicable code.

Vents connecting to horizontal sanitary piping shall connect above the centerline of the piping and shall rise at an angle of not less than 45 degrees from the horizontal to a point at least 6 inches [150 mm] above the flood level rim of the fixture served before offsetting horizontally.

Floor drains shall be adjusted to the correct elevation for proper drainage. Heads of fastening screws shall be flush with the grate surface.

Cleanouts on drainage piping inside structures shall be located where indicated on the Drawings. Additional cleanouts shall be provided where required by the applicable code or authority having jurisdiction. Cleanouts located in drainage risers shall be located 12 inches [300 mm] above the finished floor.

Unless otherwise indicated or required by the applicable code, cleanout size shall equal the line size for 4 inch [100 mm] and smaller drainage piping, and 4 inches [100 mm] in diameter for drains larger than 4 inch [100 mm]. Proper clearance shall be provided for access to cleanouts. Floor cleanouts shall be installed flush with the finished floor.

Floor drains, trench drains, floor sinks, funnel receptors, and bell-up drains indicated to be equipped with traps shall be provided with deep seal "P" traps located as close to the drain as possible.

3-3.03. Plumbing Fixtures and Accessories. Plumbing fixtures shall be set level and plumb, and shall be securely attached to the floor or wall. Unless otherwise indicated on the Drawings, each fixture shall be mounted at the height

recommended by the manufacturer. Where required to be in compliance with ADA, fixtures shall be mounted at the heights established by the Federal Government.

Fixtures shall be sealed to the floor or wall with a sealant as specified in the Joint Sealants section. The color of sealant shall match the color of the fixture.

Fixture traps shall be easily removable for servicing and cleaning. Escutcheons shall be placed at all locations where fixture supply or drain piping penetrates walls, floors, or ceilings.

Water piping at stop valves, shower heads, and flush valves shall be rigidly secured to blocking. Drop-ear elbows shall be used whenever possible. All water supply piping shall be cleaned and flushed before the plumbing fixtures are installed.

3-3.04. Plumbing Equipment. Plumbing equipment shall be installed in accordance with the manufacturer's recommendations. Adequate clearance shall be provided for access to all components which may require adjustment, servicing, or replacement.

Water heaters shall be installed in accordance with AGA, NSF, NFPA, and UL requirements. Storage type water heaters shall be cleaned and flushed before being connected to the potable water system. Water heater relief valves shall be piped to the nearest drain or as indicated on the Drawings, and shall terminate the appropriate air gap distance above the drain. Unless otherwise indicated, water heater thermostats shall be set such that the maximum water temperature does not exceed 140 ^{o}F [60 ^{o}C].

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. An installation check by an authorized representative of the manufacturer of equipment specified herein is not required.

3-4.02. Startup and Testing. Field performance tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3-5. ADJUSTING. All devices shall be adjusted for proper flow and quiet operation. Faucet and supply assemblies shall be adjusted or repaired to eliminate leaks. All drains shall be checked for proper operation.

3-6. PROTECTION. Plumbing fixtures, equipment and appurtenances shall be protected from damage immediately after installation. Plumbing fixtures shall not be used during the construction.

3-7. CLEANING. After completion of testing and immediately before the final inspection, plumbing fixtures, equipment, piping, and appurtenances shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer. All faucet aerators shall be removed, cleaned, and reinserted.

Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3-8. DISINFECTION. Before the potable water system is placed in operation, it shall be disinfected in accordance with the requirements of the local authority having jurisdiction. In the absence of local requirements, the following disinfection method shall be used:

1. The system shall be purged with clean potable water until all dirt and other substances are flushed from the system.
2. The system shall be filled with a water/chlorine solution containing at least 50 parts per million [50 mg/L] of available chlorine and allowed to stand for 24 hours; or the system shall be filled with a water/chlorine solution containing at least 200 parts per million [200 mg/L] of available chlorine and allowed to stand for 3 hours.
3. The system shall be purged with clean potable water until the chlorine is flushed from the system.
4. The procedure shall be repeated if a bacterial examination indicates that contamination remains present in the system.

3-9. OPERATOR INSTRUCTION AND TRAINING. Not used.

End of Section

Section 22 05 11
BASIC MECHANICAL BUILDING SYSTEMS MATERIALS AND METHODS

PART 1 - GENERAL

1-1. SCOPE. This section covers general mechanical building system requirements as referenced from other sections and furnishing and installation of:

Mechanical identification
Seismic restraints
Special coatings

for the plumbing and heating, ventilating, and air conditioning systems. Protective coatings for ductwork and equipment without special coatings shall be as specified in the Protective Coatings and Architectural Painting sections.

1-2. GENERAL. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by the Engineer.

1-2.01. Coordination. Where two or more units of the same class of materials are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

1-2.04. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete information, detailed specifications, and data covering materials, parts, devices, and accessories forming a part of the materials furnished, shall be submitted in accordance with the Submittals Procedures section.

Number Plates
Product data on number plates.
A listing of equipment to receive number plates shall be submitted.

Special Coatings
Name of manufacturer.
Coating type.
Color.
Chemical resistance data.
Temperature range data.
Surface preparation.
Application data.
Film thickness per coat.
Drying and curing time information.

Equipment Motors
Name of Manufacturer.
Type and Model.
Horsepower (kW) rating and service factor.
Temperature rise and insulation rating.
Full load rotative speed.
Type of bearings and method of lubrication.
Net weight.
Overall dimensions.
Efficiency at full, 3/4, and 1/2 loads.
Full load current and power factor.
Locked rotor current.

1-3.02. Samples. Samples shall be submitted in accordance with the Submittals Procedures section.

Samples of color, lettering style, and other graphic representation required for each type of identification material and device shall be submitted.

1-4. QUALITY ASSURANCE.

1-4.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's

review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1-4.02. Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1-5. EXTRA MATERIALS. The following extra materials shall be furnished for the listed equipment:

Touchup special coating material

Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet [610 m] above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2-2.03. Equipment Efficiencies. Unless otherwise indicated in the respective equipment paragraph, the equipment efficiency shall be in accordance with the requirements of ASHRAE Energy Standard 90.1.

2-2.04. Drive Units. Drive units shall be designed for 24 hour continuous service.

2-2.04.01. V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable belt tension adjustment. V-belt drives shall have a service factor of at least 1.5 at maximum speed based on the nameplate horsepower [kW] of the drive motor unless otherwise indicated in the specific equipment paragraph. Multiple belts shall be provided in matched sets and shall be oil resistant, non-static type. External belts and drive assemblies shall be protected by a belt safety guard constructed in accordance with OSHA requirements. The guard shall be provided with a tachometer opening.

Unless otherwise indicated in the specific equipment paragraph, equipment with smaller than 10 horsepower [7.5 kW] motors shall have adjustable pitch sheaves and equipment with 10 horsepower [7.5 kW] and larger motors shall have fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required speed for the specified airflow.

2-2.04.02. Electric Motors. Motor horsepower scheduled on the Drawings are minimum motor horsepower. Larger motors shall be provided if required to meet the specified capacities for the equipment furnished. Motors furnished with equipment shall meet the following requirements.

a. Premium efficient motors with a minimum efficiency of at least that specified in the Common Motor Requirements for Process Equipment section shall be provided where available as a standard option. All other motors shall meet the minimum efficiency standards required by the 2007 Energy Independence and Security Act.

b. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

c. Rated for continuous duty at 40°C ambient.

d. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet [1005 m], explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1

for insulation class, service factor, and motor enclosure type.

e. To ensure long life, motors shall have nameplate horsepower [kW] equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp [kW]	Open	1.15
	Other Than Open	1.0
Integral hp [kW]	Open	1.15
	Other Than Open	1.0

Motors used with adjustable frequency drives shall have a 1.15 service factor on sine wave power and a 1.0 service factor on drive power.

f. Designed for full voltage starting.

g. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

h. Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

i. Bearings shall be either oil or grease lubricated.

j. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

k. Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

l. Totally enclosed motors shall be furnished on:

(1) Outdoor equipment.

(2) Equipment for installation below grade.

(3) Equipment operating in chemical feed and chemical handling locations.

(4) Equipment operating in wet or dust-laden locations.

m. Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

n. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard

design. However, in all cases, the motor types indicated are preferred and shall be furnished if offered by the manufacturer as a standard option.

o. Motors used with adjustable frequency drives shall have insulation system meeting the requirements of NEMA MG 1, Part 31.

2-3. MANUFACTURE AND FABRICATION.

2-3.01. Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2-3.02. Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage in Concrete and Masonry section unless otherwise indicated on the Drawings.

2-3.03. Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2-3.04. Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2-4. MATERIALS.

2-4.01. Mechanical Identification. Mechanical identification consisting of equipment number plates, equipment information plates, valve tags, and ductwork identification shall conform to the requirements of the Equipment and Valve Identification section and as indicated herein.

2-4.01.01. Number Plates. Hand-lettered or tape labels will not be acceptable.

Number plates for control equipment such as but not limited to thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the specific device identification list the controlled equipment in parenthesis below the device number.

2-4.01.02. Piping. Piping identification shall be as specified in the Protective Coatings section. The lettering size, length of color field, colors, and viewing angles of identification devices shall be in accordance with ASME A13.1.

2-4.01.03. Valves. Valve tags shall indicate if the valve is normally open or normally closed.

2-4.01.04. Ductwork. Ductwork shall be identified with nameplates as specified herein, or stenciled painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

2-4.02. Seismic Design. All ductwork and piping associated with the plumbing and HVAC systems shall be provided with seismic restraints in accordance with Seismic Hazard Level (SHL) of the latest edition of the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems as specified and in accordance with the applicable building code. The seismic hazard level used to design the restraints shall be level ABCD. Water heaters shall be restrained in accordance with the applicable plumbing code. Equipment and associated attachments and restraints shall be in accordance with the Meteorological and Seismic Design Criteria section.

2-4.03. Special Coatings. Where indicated on the Drawings, sheet metal ductwork, dampers, registers, grilles, coils, and equipment shall be given a special coating suitable for the corrosive atmosphere indicated. Sheet metal ductwork, dampers, registers, grilles, coils, and equipment construction shall be suitable to allow proper application of the special coating system in accordance with the manufacturer's recommendation.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by the Engineer.

The installation of identifying devices shall be coordinated with the application of covering materials and painting where devices are applied to surfaces. All surfaces to receive adhesive number plates shall be cleaned before installation of the identification device.

End of Section

Section 22 11 19

BACKFLOW PREVENTERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of backflow preventers and associated appurtenances, as indicated herein. Backflow preventers for fire protection service shall be as specified in the fire sprinklers systems section.

Piping, pipe supports, insulation, and accessories which are not an integral part of the backflow preventers or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to the following:

Name of manufacturer.
Type and model.
Construction materials and finishes.
Net weight.
Unit dimensions.
Performance curves indicating flow capacity versus pressure drop.

1-3.02. Operations and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and Storage shall be in accordance with the manufacturer recommendations and this Section.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Backflow preventers shall be designed to meet the requirements as indicated herein and in the Backflow Preventer Schedule on the Drawings.

2-2. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Design and Construction paragraph.

2-3. DESIGN AND CONSTRUCTION. Backflow prevention device type shall be as indicated herein.

2-3.01. Reduced Pressure Zone Backflow Preventers. Reduced pressure zone (RPZ) backflow preventers shall consist of isolation valves, two independent check valves, and differential relief valve. The assembly shall automatically reduce the pressure in the zone between the check valves. In the event that the reduced pressure is not maintained, the differential relief valve shall open, maintaining the proper zone differential. RPZ backflow preventers shall comply with AWWA C511 and ASSE Standard 1013 requirements and shall be suitable for horizontal installation. Backflow preventers shall comply with the requirements of ANSI/NSF 61, Annex G for low lead. Each RPZ backflow preventer shall be provided with a relief valve air-gap drain fitting.

RPZ backflow preventers in 2 inch [50 mm] and smaller sizes shall be provided with bronze bodies and with a threaded bronze bodied ball valve on each end of the device. Two inch [50 mm] and smaller RPZ backflow preventers shall be Febco “Model LF860”, Wilkins “Model 975XL2”, or Watts Regulator “Series LF919”.

RPZ backflow preventers in 2-1/2 inch [63 mm] and larger sizes shall be provided with 304 stainless steel or ductile iron bodies with epoxy-coated interior and exterior, and a flanged, resilient-seated gate valve on each end of the device. Flange diameter and drilling shall conform to ANSI/ASME B16.1, Class 125. 2-1/2 inch [63 mm] and larger RPZ backflow preventers shall be Wilkins “Model 375” or Watts Regulator Company “Series 957”.

2-3.02. Hose Connection Vacuum Breakers. Hose connection vacuum breakers shall be provided with 3/4 inch [19 mm] hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, manual drain feature, and shall comply with ASSE Standard 1011 requirements. Hose

connection vacuum breakers shall be Febco “Series 731”, Watts Regulator Company “Series 8” or Wilkins “Model BFP 8”.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

Section 22 11 26

WATER METERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of water meters and associated appurtenances.

Pipe materials, valves, insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Meters specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication, assembly and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.
Type and model.
Construction materials, thicknesses, and finishes.
Performance curves indicating flow capacity versus pressure drop.
Accuracy.
Pressure and temperature ratings.
Overall dimensions.
Piping connection sizes and locations.
Net weight.
Wiring diagrams.

1-3.02. Operation and Maintenance Data and Manuals. Not used.

1-4. QUALITY ASSURANCE.

1-4.01. Construction. Water meters shall be constructed in accordance with the following standards:

Displacement Water Meters	AWWA C700
Turbine Water Meters	AWWA C701
Compound Water Meters	AWWA C702

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Water meters shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Water meters shall be designed to meet the performance and design conditions indicated herein, on the Drawings, and on the water meter schedule.

Each meter shall measure the actual flow within the accuracy specified over the indicated flow range with a water temperature range of 32 ^{o}F [0^{o} C] to 120 ^{o}F [50^{o} C]. The accuracy shall be expressed as a percentage of the actual flow and not as a percent of maximum flow.

Meter assemblies shall have performance capabilities of continuous operation up to the rated maximum flows without affecting long-term accuracy or causing any undue component wear. All meter assemblies shall also have a 25% flow capacity in excess of the maximum flows listed for intermittent flow demands.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. DESIGN AND CONSTRUCTION.

2-4.01. Displacement Meters. Displacement meters shall be nutating or oscillating disc type with bronze or synthetic polymer housing as indicated in the schedules, thermoplastic plastic chamber and hard rubber disc. Accuracy shall be ± 1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32 °F [0° C] to 120 °F [50° C] and a working pressure of 150 psi [1,050 kPa]. Each meter shall be provided with threaded union type spud end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Displacement type meters shall be Badger Meter Inc., "Recordall Disc Meter" or ABB Water Meters, Inc.

2-4.02. Turbine Meters. Turbine meters shall be moving rotor type with bronze, cast iron, or 316 stainless steel housing as indicated in the schedules, thermoplastic rotor, ceramic bearings, stainless steel straightening vanes, Buna N "O" ring, and Nitrile head gasket. Accuracy shall be ± 1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32 °F [0° C] to 120 °F [50° C] and a working pressure of 150 psi [1,050 kPa]. Meters in 2 inch and smaller sizes shall be provided with threaded union type spud end connections. Meters in larger than 2 inch sizes shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Turbine type meters shall be Badger Meter Inc., "Recordall Turbo Meter" or ABB Water Meters, Inc.

2-4.03. Compound Meters. Compound meters shall incorporate a positive displacement chamber for measuring low flows, a turbine chamber for measuring high flows, and a valve for diverting flow to the respective chamber. Compound meters shall be provided with a single housing or may be provided with independent housings factory piped with a single inlet and outlet connection. Meters shall be provided with bronze housings and piping, thermoplastic rotor, valve casing, and disc chamber, and stainless steel straightening vanes. Accuracy shall be ± 1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32 °F [0° C] to 120 °F [50° C] and a working pressure of 150 psi [1,050 kPa]. Meters shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Compound type meters shall be Badger Meter Inc., "Recordall Compound Meter", or ABB Water Meters, Inc.

2-4.04. Propeller Meters. Not used.

2-5. PAINTING AND COATINGS.

2-5.01. Surface Preparation. All iron and steel surfaces shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint or coating manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2-5.02. Shop Painting. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Coatings located in water passages shall comply with AWWA requirements for use with potable water and shall be NSF 61 certified. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the painting section.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3-2. INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Meters shall be installed with the required upstream and downstream straight pipe lengths as recommended by the manufacturer.

3-3. ADJUSTING. Meters shall be calibrated and adjusted according to manufacturer's written instructions after installation. Meter faces shall be adjusted to proper angle for best visibility.

3-4. PROTECTION. Meters and appurtenances shall be protected from damage immediately after installation. Scratched, cracked or broken components shall be replaced. Meters shall not be used during the construction.

3-5. CLEANING. After completion of testing and immediately before the final inspection, meters shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer.

End of Section

Section 22 13 17

CAST IRON SOIL PIPE AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of cast iron soil pipe and accessories for the service conditions as specified herein. Cast iron soil pipe shall be furnished complete with all fittings and other accessories.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Items requiring submittals shall include, but shall not be limited to, the following:

Pipe, Gaskets, and Couplings.
- Name of Manufacturer.
- Type and Model.
- Construction materials, thickness, and finishes.
- Coating product data sheets.
- Certification by manufacturer that the pipe and fittings furnished are in accordance with referenced standards. Certification shall include legal name and address of the manufacturer.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and Storage shall be in accordance with the manufacturer recommendations and this Section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2-1. MATERIALS.

2-1.01. Product Marking. Pipe and fittings shall bear manufacturer's product marking as required by the referenced standards. Markings shall be plainly marked including but not limited to country of origin, manufacturer's name, and date of manufacturer.

2-1.02. Material Classification CI-1.

CI-1 – Bell and Spigot Building sanitary drain, waste, and vent piping, except where buried. Building storm drain piping, except where buried. Clear water waste piping, except where buried.	Pipe and Fittings Jointing Material	ASTM A74 Rubber gaskets, ASTM C564.

2-1.03. Material Classification CI-2.

CI-2 – Hubless Building sanitary drain, waste, and vent piping, all locations except where buried. Building storm drain piping, all locations except where buried. Clear water waste piping, all locations except where buried.	Pipe and Fittings Jointing Material	CISPI 301. Heavy duty coupling, with neoprene rubber sleeve, 304 stainless steel shield, and stainless steel clamping bands, or bolted cast iron coupling with stainless steel bolts and neoprene gasket. Couplings shall be Clamp-All Products “HI-TORQ 125”, Husky “SD 4000”, Mission Rubber Company LLC “HeavyWeight Coupling”, or MG Piping Products “MG Coupling”, without exception.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Section 23 00 00

HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of heating, ventilating, and air conditioning (HVAC) equipment, devices, and appurtenances associated with the HVAC systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are needed, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1-2.05. Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1-2.06. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Packaged Air Handling Units
- Name of manufacturer.
- Type and model.
- Construction materials, thickness, and finishes.
- Capacities.
- Filter velocities.
- Overall dimensions and required clearances.
- Net weight and load distribution.
- Performance tables with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute[m3/s], speed or rpm, brake horsepower, and static pressure listed.
- Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.
- Electrical requirements including voltage, number of phases, and amperage.
- Where specified, information on equipment manufacturers' representatives.

Fans
- Name of manufacturer.
- Type and model.

Construction materials, thickness, and finishes.
Overall dimensions and required clearances.
Net weight and load distribution.
Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute [m3/s] as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.
Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.
Where specified, information on equipment manufacturers' representatives.

Equipment (not specifically listed)

Name of manufacturer.
Type and model.
Construction materials, thickness, and finishes.
Manufacturer's performance data.
Overall dimensions and required clearances.
Net weight and load distribution.
Wiring diagrams.

Sheet Metal Ductwork

Sheet metal duct fabrication drawings indicating dimensions of individual shop and field fabricated sections, top and/or bottom duct elevations, joint locations, and dimensions of duct from walls or column rows.
Pressure and seal classifications.
Reinforcement types and spacing.
Joint and seam types.
Hanger and support types, spacing, and attachment methods.
Access panel and door construction, sizes, and locations.
Duct sealant, adhesive, gasket, and tape information.

Ductwork materials and thicknesses.
Product data demonstrating compliance with ASHRAE 62.1

Temperature Controls

Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.
Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to

each other. These diagrams shall also show detailed multiline wiring with all terminals accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

Sequence of operation for each system corresponding to the control schematics.

Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

Space thermostat schedule indicating the types of covers and means of adjustment for each space.

Conduit and wire types.

Where specified, information on equipment manufacturers' representatives.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1-4. QUALITY ASSURANCE. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and Storage shall be in accordance with the manufacturer recommendations and this Section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

Gas fired equipment shall be suitable for operation with the gas inlet pressure range specified in the individual equipment paragraphs.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve to the left of the peak pressure/efficiency point.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MATERIALS.

2-4.01. Gas Vent Systems. Gas vent systems shall be provided for all equipment that exhausts combustible material. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Gas vent system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions and to any local codes which pertain to such work.

2-4.01.01. Factory Built Gas Vents. Factory built gas vent piping and fittings shall be laboratory tested, listed by Underwriters Laboratories, and shall comply with NFPA 211. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

Gas vent systems for category I vented equipment shall be Selkirk Metalbestos or Metal-Fab, "Type B" gas vents. The vents shall be of double wall construction, with at least a 0.25 inch air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.012 inch aluminum and the outer jacket of at least 0.018 inch galvanized steel.

Gas vent systems for category II, III, and IV unit heaters with vents 5 inch and smaller shall be Selkirk Metalbestos "Model DCV" or Heat-fab special gas vent. The vent pipe and fittings shall be of double wall construction with a nominal 0.5 inch air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.016 inch AL29-4C stainless steel and the outer jacket shall be constructed of at least 0.016 inch Type 304 stainless steel.

Chimney and vent systems for category II, III, and IV equipment with vents 6 inch [150 mm] and larger shall be Selkirk Metalbestos "Type PS" gas vent or Metal-Fab "Model PIC". The vent pipe and fittings shall be of double wall construction with a nominal 1 inch air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch AISI Type 316 stainless steel and the outer jacket shall be constructed of at least 0.024 inch aluminum coated steel for interior locations and AISI Type 316 stainless steel for the portions of the stack exposed to the outdoor environment.

2-4.01.02. Metal Gas Connectors. Metal gas vents shall be used indoors where the gas vent is not directly connected to the equipment and shall be constructed of at least 20 gage thickness galvanized steel. The connector shall be sized and arranged as recommended by the vented equipment manufacturer or as directed by Engineer. The gas vent system shall include all necessary fittings, hangers, supports, and flashings.

2-4.02. Packaged Air Handling Units. Packaged air handling units, denoted by the symbol "AHU" and an identifying number, shall be furnished and installed where indicated on the Drawings. Each unit shall be designed for indoor vertical or horizontal installation as indicated on the Drawings consisting of cabinet, coil(s), filter, drain pan, fan, and motor. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1. The air handling unit manufacturer shall be Aaon, Trane and Diakin.

2-4.02.01. Extra Materials.

Extra Materials	Quantity
Sets of air filters per unit	2

2-4.02.02. Performance and Design Requirements. The units shall be completely factory assembled and tested, piped, internally wired, and shipped in one piece. Each unit shall be designed for direct expansion cooling suitable for use with the specified refrigerant. The unit shall be suitable for the power supply and shall have the capacities indicated on the Drawings.

2-4.02.03. Cabinet. The unit shall be constructed of zinc-coated steel properly reinforced and braced for maximum rigidity. The unit shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard enamel finish. Interior surfaces of the unit shall have 1 inch [25 mm] thick, 1 lb [454 kg] density, insulation foil faced or coated on the air side. Removable panels shall be provided to permit easy inspection and maintenance.

2-4.02.04. Coil Section. The coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory pressure and leak tested to at least 300 psig or greater as needed for the system operating pressures. The coil shall be provided with expansion device or valve and filter-dryer. The coil section shall have fully insulated, sloped drain pan extending under the coil section and arranged to capture and collect any condensate including carryover that may be produced when the unit is operating within the specified operating conditions. The drain pan construction shall comply with the requirements of ASHRAE 62.1.

2-4.02.05. Heating Section. Where indicated on the Drawings, the units shall be provided with electric heating coils. Electric coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium elements with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code.

2-4.02.06. Fans and Motors. The indoor supply fan shall be a double inlet, forward-curved, multiblade, centrifugal type statically and dynamically balanced by the unit manufacturer. The fan shall be direct or belt driven as indicated on the Drawings. Direct drive fans motors shall be multispeed with integral thermal-overload protection. Where belt driven fans are used, adjustable mounts and adjustable motor pulleys shall be provided.

Static pressure values indicated on the Drawings are external to the complete unit. Internal coil(s), filters and fan housing losses are not included. A filter allowance of 0.15 inch water column shall be used for 1 inch pleated filter losses and 0.35 inch water column shall be used for 2 inch pleated filter losses.

2-4.02.07. Filters. Filters shall be mounted integral within the unit and shall be 2 inches thick unless otherwise indicated on the Drawings. Filters shall conform to the requirements in the Air Filtration Equipment paragraph.

2-4.02.08. Controls. A thermostat for operation of the unit shall be furnished and installed as indicated on the Drawings. The thermostat shall be as needed to perform the sequence of operation as indicated on the Drawings. Thermostats shall be programmable wall mounted type and shall conform to the requirements of the Thermostats paragraph.

2-4.03. Furnaces. Not used.

2-4.04. Makeup Air Units. Not used.

2-4.05. Heaters. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the Drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2-4.05.01. Electric Duct Heaters. Not used.

2-4.05.02. Electric Unit Heaters. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the Drawings.

a. Electric Unit Heaters (heavy-duty). Electric unit heaters located in unclassified areas shall be Chromalox "LUH", or Brasch. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the Drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal

overload protection. Where shown on the Drawings to be wall hung, a wall mounting bracket shall be provided.

b. Electric Unit Heaters (explosionproof). Not used.

c. Electric Unit Heaters (corrosion resistant). Not used.

2-4.05.03. Gas Unit Heaters. Gas unit heaters, denoted by the symbol "GUH" and an identifying number, shall be Sterling “GG” or “TF”, Trane “GT” or “GH”, or Modine “HD” or “PDP”. Gas unit heaters shall be designed for use with natural gas at a pressure range of 10-14 inches w.c. .Each unit shall have a combustion efficiency of at least 80 percent.

Gas unit heaters shall be furnished and installed where indicated on the Drawings. Each heater shall be of the type, size, and capacity indicated in the schedules on the Drawings; shall be suitable for use with the gas type and pressure as required; and shall be independently listed and certified to conform with the latest ANSI standards for safe and efficiency performance.

Each gas-fired unit heater shall be power vented, horizontal discharge, propeller type, and suitable for suspending mounting as indicated on the Drawings. The heat exchanger shall be constructed of E-3 (AISI Type 409) stainless steel. Each heater shall be furnished with a vent cap.

Each heater shall be capable of operating with conventional vertical or horizontal venting with up to 20 feet of straight venting system plus an additional allowance for at least two 90 degree elbows and a termination cap.

Each gas unit heater shall be furnished complete with a 24 volt transformer, single-stage gas control with a regulated combination redundant gas valve, spark-ignition system with electronic flame supervision, and all required limit and safety controls. Units larger than 125,000 Btu input shall have two-stage gas controls.

The fan motor shall be suitable for use with a 120 volt, 60 Hz, single phase power supply, and shall be provided with automatic reset thermal overload protection.

2-4.05.04. Wall Heaters. Not used.

2-4.06. Fans. Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the Drawings, and shall be UL listed. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1.

Each fan shall be complete with an electric motor, factory mounted safety disconnect switch with wiring to the motor, drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower [7.5 kW] motors and fixed sheaves for 10 horsepower [7.5 kW] and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

Fan drive motors shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the Drawings.

Fans indicated in the schedules on the Drawings to be spark resistant construction shall be suitable for installation in a NEC Class I, Division 1 and 2, Group D environment. The fan shall have an AMCA spark resistant construction classification Type A or better and be equipped with non-static belts.

The external static pressure values indicated in the schedules on the Drawings are external to the complete unit. Internal fan housing and when furnished, backdraft damper and filter losses are not included. An allowance of 0.35 inch water column [87 Pa] shall be used for pleated filter losses.

A solid state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp [0.4 kW] to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

Where indicated in the schedules on the Drawings, fans shall be given a special coating resistant to the corrosive atmosphere indicated.

2-4.06.01. Extra Materials.

Extra Materials	Quantity
Sets of matched belts per fan	1

2-4.06.02. Cabinet Fans. Not used.

2-4.06.03. Duct Fans. Duct fans, denoted by the symbol "DF" in the fan schedule shall be Greenheck "SQ/BSQ", PennBarry, or Loren Cook. Duct fans shall be of the centrifugal in-line type, and shall be direct or belt driven, as indicated in the schedules on the Drawings. Fan wheels shall be aluminum, backward inclined type, dynamically and statically balanced at the factory.

The fan housing shall be square, constructed of steel, aluminum steel or aluminum as scheduled on the Drawings, and shall be furnished with duct mounting collars. Access doors or panels shall be provided for servicing internal parts without removing the fan from the ductwork. Vibration isolation units shall be provided for each unit. The interior of the fan housing shall be lined with 1 inch [25 mm] fiberglass duct liner.

Motors and drives shall be isolated from the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, relubricatable or permanently sealed bearings with a minimum L_{50} service life of at least 200,000 hours at the equipment's maximum cataloged operating conditions.

Flexible wiring leads shall be provided from the fan motor to the safety disconnect switch which shall be accessible for servicing without disconnecting the field wiring.

2-4.06.04. Power Roof Ventilators. Not used.

2-4.06.05. Propeller Fans. Propeller fans, denoted by the symbol "PF" in the fan schedule shall be Greenheck "Model S/SC" for direct drive and "Model SB/SBC" for belt drive, PennBarry, or Loren Cook.

Propeller fans shall consist of a panel frame, wire guard, motor, fan blades, and a disconnect switch. Fan blades shall be constructed of aluminum. Propeller fans shall be statically and dynamically balanced to ensure quiet, vibration-free operation, and be suitable for mounting as indicated.

When indicated in the schedules on the Drawings, a wall mounting kit shall be provided. The wall mounting kit shall consist of a wall collar, motor wire guard, backdraft damper, and weather hood with birdscreen.

2-4.06.06. Utility Fans. Not used.

2-4.06.07. Wall Fans. Not used

2-4.07. Roof Hoods. Not used.

2-4.08. Dampers.

2-4.08.01. Backdraft Dampers. Backdraft dampers, denoted by the symbol "BDD" not specified to be furnished with equipment, shall be Arrow United Industries "Type 655", or Ruskin “BD6”. Backdraft dampers shall be constructed with a 1 by 4 inch by 0.081 inch thick [25 by 100 mm by 2 mm] extruded aluminum frame. Blades shall be at least 0.070 inch [1.75 mm] aluminum with blade edge seals mechanically locked to blade edge and aluminum shafts operating in synthetic bearings. The leakage rate shall not exceed 20 cubic feet per minute per ft^2 [102 $L/s/m^2$] when tested at 1 in wc [0.25 kPa] for all sizes 24 inches [610 mm] wide and above.

2-4.08.02. Control Dampers. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet [2.3 m^2] or with any blade dimension exceeding 48 inches [1200 mm] shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit. The leakage rate shall not exceed 4 cubic feet per minute per ft^2 [20 $L/s/m^2$] when tested at 1 in wc [0.25 kPa] for all sizes 24 inches [610 mm] wide and above.

Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

Control dampers shall be given a special coating identical to the coating applied to the connected ductwork and equipment.

a. Duct Mounted Control Dampers. Control dampers mounted in ductwork and equipment curbs shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-50". The damper frames shall be constructed of 5 inch [125 mm] Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch [150 mm] wide airfoil-shaped extruded aluminum.

b. Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-40". Control damper frames shall be constructed of 4 by 1 inch [100 by 25 mm] 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch [100 mm] wide airfoil-shaped extruded aluminum.

c. Round Control Dampers. Round control dampers shall be Arrow United Industries "Type 70, 75, or 80". The damper frames and blades shall be constructed of 0.080 inch [2 mm] aluminum.

2-4.08.03. Volume Control Dampers. Volume control dampers shall be denoted by the symbol "VCD".

Galvanized volume control dampers in round ductwork shall be Arrow United Industries "Type 200 VCRD", or Ruskin “Model MDRS25”. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type 1770", or Ruskin “Model MD35”. Rectangular volume control dampers shall be fabricated of 16 gage [1.52 mm] thickness galvanized steel, with a nominal 4 or 5 inch by 1 inch [100 mm or 125 mm by 25 mm] channel frame, and opposed operating blades. Round dampers shall be fabricated of galvanized steel, with a nominal 7 inch [178 mm] long, 22 gage [0.76 mm] thickness frame, and a minimum 20 gage [0.91 mm] thickness circular blade.

Aluminum volume control dampers in round ductwork shall be Arrow United Industries "Type 75", or Ruskin “Model CDRS25”. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type OBDPL-507", or Ruskin “Model CD51”. Round dampers shall be fabricated of aluminum, with a nominal 7 inch [178 mm] long, 0.080 inch [2 mm] thick frame, and a minimum 0.080 inch [2 mm] thick circular blade. Rectangular volume control dampers shall be fabricated with a 1 by 4 or 5 inch by 0.081 inch thick [25 by 100 or 125 mm by 2 mm] extruded aluminum frame and opposed operating blades. Blades shall be of .125 inch [3 mm] thick aluminum with aluminum shafts and ball bearings.

The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

2-4.09. Damper Operators. The damper operators shall be direct coupled or foot-mounted type. Each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

Each operator shall have sufficient torque to operate the connected control damper based on at least 130 percent of control damper area. Each damper operator shall have at least a 50 inch-pound [5.6 N-m] normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators or operators with a greater running torque shall be furnished to produce the torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the Drawings.

Two-position direct coupled electric damper operators shall be Belimo "NFBUP-S" or “AFBUP-S”, Honeywell "MS4100 Series", or Johnson Controls. Foot-mounted type electric damper operators shall be Honeywell "Model M4185", or Johnson Controls "Model M100".

Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac or the power supply available from the temperature control system furnished. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA enclosure with a rating equal to or better than the damper operator.

a. Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable for round shafts. The operators shall be suitable for direct mounting to shafts up to 1 inch [25 mm] and shall be complete with mounting brackets and damper position indicator.
b. Foot-mounted type two-position electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch [9.5 mm] square, double-ended drive shaft.

2-4.10. Air Outlet and Inlet Devices. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, or Titus. Air outlet and inlet devices shall be furnished and installed where indicated on the Drawings.

Where air outlet and inlet devices are installed in ductwork given a special coating, an identical coating shall be applied to the air outlet and inlet devices.

2-4.10.01. Ceiling Diffusers. Diffusers shall be square or rectangular, constructed of the materials indicated in the schedules on the Drawings. Diffusers shall have a key-operated, opposed-blade damper mounted in the neck where indicated in the schedules on the Drawings. Size, location, and direction of airflow shall be as indicated on the Drawings.

2-4.10.02. Registers and Grilles. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the Drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

2-4.11. Flexible Connections. Flexible connections located indoors shall be Ventfabrics "Ventglas". Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon".

Ductwork connections to the air handling equipment, and where indicated on the Drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches [76 mm] of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20 to 180°F [-29 to 82°C] and shall weigh at least 27 ounces per square yard [915 g/m^2].

Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10 to 250°F [-23 to 121°C] and shall weigh at least 24 ounces per square yard [814 g/m^2].

2-4.12. Air Filtration Equipment.

2-4.12.01. Pleated Air Filters. Pleated air filters shall be American Air Filter "AM-AIR 300X" or Farr "30/30". Filters shall be disposable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have a minimum efficiency reporting value (MERV) based on the ASHRAE 52.2 guidelines of at least MERV 6.

Two inch [50 mm] pleated air filters shall have at least 12 pleats per linear foot [0.3 m] and at least 4.2 square feet of media per square foot of filter area. [4.2 square meters per square meter]. Two inch [50 mm] filters shall have a maximum initial resistance of 0.13 inch water column at 300 feet per minute [32 Pa at 1.5 m/s].

2-4.12.02. Side Access Filter Housings. Side access filter housings shall be American Air Filter "Access Air" or Farr "Model 4P Glide/Pack". Side access filter housings shall be single-stage, factory-fabricated of 16 gage [1.52 mm] thickness galvanized steel and shall be equipped with flanges for connection to the ductwork. Access doors shall be 16 gage [1.52 mm] thickness galvanized steel and shall be positioned to allow replacement of filters from either side of the housing. Filter housings and doors shall be insulated and of double-wall construction. Filter tracks shall be provided to accommodate nominal 2 inch [51 mm] thick disposable filters as described herein. Leakage at the rated airflow shall be less than 1 percent at a 3 inch water column [0.75 kPa] differential.

2-4.13. Draft Gauges. Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge".

Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch [89 mm] diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20 to 140°F [-7 to 60°C], and a range of 0 to 1.0 inch water column [0.25 kPa], with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves. When mounted across filters, the signal flag shall be set at 0.75 inch water column [190 Pa].

2-4.14. Sheet Metal Ductwork. Ductwork, accessories, bracing, and supports shall be constructed of galvanized steel . Where more than one material is indicated, ductwork, accessories, bracing, and supports shall be constructed of galvanized steel unless otherwise indicated on the Drawings. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards unless otherwise indicated. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork.

Galvanized ductwork located in air conditioned spaces shall be constructed of G-60 or better lockforming quality in accordance with ASTM A653. All other galvanized ductwork shall be constructed of G-90 or better galvanized steel. All welds on galvanized metal shall be cleaned and coated with a zinc-rich paint.

Plenums shall be constructed of reinforced 16 gage [1.52 mm] thickness galvanized sheet metal.

Sheet metal fan boxes shall be fabricated with 12 gage [2.66 mm] thickness galvanized sheet metal skin and structural steel framing of sufficient strength to support the fan box and the fan mounted on the box. Drawings of the fan boxes shall be submitted in accordance with the Submittals Procedures section.

Sealants shall be suitable for the duct service and shall maintain leakage integrity at pressures in excess of the ductwork pressure classification.

Where indicated on the Drawings, ductwork and accessories shall be given a special coating resistant to the corrosive atmosphere indicated. Where no special coating for ductwork is indicated, the coating shall be as specified in the Protective Coatings and Architectural Painting sections.

2-4.15. Duct Insulation. Interior duct liner shall be Knauf "Sonic XP Duct Liner", CertainTeed "ToughGard R", or Johns Manville " Linacoustic RC".

Interior duct liner shall be 1-1/2 pound per cubic foot [24 kg/m^3] density, spray coated duct liner with an "R" value of at least 4.2 ft^2 hr F/BTU [0.74 m^2°C/W] per inch [25 mm] thickness at 75°F [24°C]. The insulation shall be suitable for temperatures up to 250°F [121°C] and shall have at least a 0.55 NRC per 1 inch [25 mm] thickness. The insulation shall conform to ASTM C1071. The insulation surface shall be resistant to microbial growth in accordance with UL 181, ASTM C1338, or comparable test method and shall be cleanable in accordance with NAIMA recommended practices.

2-4.16. Flexible Duct and Takeoffs. Flexible duct shall be Thermaflex “Type G-KM” or Flexmaster "Type 8". Takeoffs shall be Buckley Air Products "Air-Tite Bellmouth BM-D".

Flexible duct shall be a galvanized or vinyl-coated spring steel helix, bonded to a polymer liner, and wrapped with glass fiber insulation suitable for use in heating and cooling systems. The insulation shall provide an "R" value of at least 4.2 ft^2·hr°F/BTU [0.74 m^2°C/W]. The outer jacket shall be a vapor barrier of fire retardant polyolefin or polyethylene material. The flexible duct shall be listed under UL 181 as Class 1 flexible air duct and shall comply with the latest edition of NFPA 90A.

Takeoffs for the flexible duct shall be bellmouth type manufactured of the same material as the associate ductwork with a neoprene gasket and predrilled holes. Each takeoff shall be equipped with a balance damper constructed of 26 gage [0.45 mm] thickness galvanized steel. Scoops or other obstructions in the main duct will not be acceptable.

2-4.17. Access Doors. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Insulated doors shall be insulated with the same

thickness insulation as the duct in which it is installed. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

2-4.18. Temperature Controls. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; or Siemens Building Technologies, Landis Division. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2-4.18.01. Performance and Design Requirements. Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating,

ventilating, and air conditioning equipment furnished and their interconnection. Where cable and conduit is not indicated on the Drawings but is needed for a complete and functional control system in accordance with the sequence of operation it shall be provided as specified herein. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation.

Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper actuators, thermostats, temperature control panels, pressure differential switches, control switches, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the Electrical Wiring paragraph. Cable and conduit for all HVAC power circuits shall be as specified in the Electrical section.

2-4.18.02. Tolerances. Unless otherwise indicated, the controls shall maintain space temperatures within ±2°F [1.1°C], and the relative humidity within ±5 percent of the setpoint.

2-4.18.03. Thermostats. Where indicated on the Drawings, thermostats shall be constructed of materials resistant to or shall be protected from the corrosive atmosphere indicated. Thermostats specified in the individual equipment paragraphs shall be provided with the respective equipment.

a. Two Position Wall Mounted Thermostats. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch", Penn Controls "A19BAC-1", or Siemens Building Technologies.

   Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F [2°C to 38°C] with a nonadjustable differential of 3.5°F [2°C]. The thermostats shall have a spdt switch rated for 1 horsepower [0.746 kW].

b. Low Limit Thermostats. Not used.

c. Modulating Duct Mounted Thermostats. Not used.

d. Explosion-proof Thermostats. Not used.

2-4.18.04. Temperature Control Panels. Temperature control panels, denoted by the symbol "TCP" and an identifying number, shall be manufactured by Hoffman Engineering, Hubbell Wiegman, or Rittal Corporation. Temperature control panel enclosures shall be NEMA Type 12 unless otherwise indicated on the electrical Drawings with a special area designation. Where a panel is located in a room with a special area designation, the panel shall be constructed to meet the special area designation requirements. Panels shall be designed for wall mounting and shall be completely prewired and checked. All electrical accessory devices and internal wiring shall be furnished and installed.

Where required by the applicable codes and ordinances, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing agency acceptable to the governing authority.

All controllers, selector relays, switching relays, interlock relays, manual switches, timers, alarm, and other devices indicated to be panel mounted shall be mounted in or on the respective control panel. Accessories such as indicating lights, pushbuttons, alarm horns, and selector switches shall be mounted on the front hinged covers of the panels. The accessories and panels shall be identified with an identification plate as described in the Equipment Identification paragraph. The identification plates shall be fastened to the panel with corrosion-resistant pan head screws.

Each temperature control panel shall supply power to all associated control system field control components, including but not limited to, damper operators, thermostats, sensors, and smoke detectors. The controls shall include all necessary relays, interlocks, and control devices to enable the control panel to function as described in the sequence of operation on the Drawings.

All interconnecting wiring and wiring to terminals for exterior connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame resistant covering rated for at least 90°C. Power distribution wiring on the line side of panel fuses shall be at least 12 AWG. Wiring for secondary power distribution and for control, annunciator, and indicating light circuits shall be at least 14 AWG. Wiring shall be color coded in accordance with the legend on the panel wiring diagrams.

Equipment operational control and run/off status shall be provided from terminal blocks within the respective motor starter. Refer to the electrical Drawings for additional information.

a. Selector Switches. Selector switches shall be Micro Switch "Type PT", Cutler-Hammer "10250T Series ", or General Electric "CR". Selector switches shall be heavy-duty 30 mm oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the Drawings or as necessary for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty.

b. Push Buttons. Push buttons shall be Micro Switch "Type PT", Cutler-Hammer "10250T Series", or General Electric "CR". Push buttons shall be heavy-duty, oiltight type, with legends engraved on the faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac.

c. Indicating Lights. Indicating lights shall be Micro Switch "Type PT", Cutler-Hammer "10250T Series ", or General Electric "CR". Alarm, indicator, and running status lights shall be furnished with lamps. Indicating lights shall be heavy-duty, 30 mm, push-to-test, oiltight type with LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the device.

d. Alarm Horns. Alarm horns shall be Federal Signal "Model 350". Alarm horns shall have a sound output of 100 dB at 10 feet [3 m]. Horns shall be furnished with mounting hardware suitable for flush mounting.

e. Relays. Relays shall be Eagle Signal "Series 22, 80"; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series A3, A4". Relays shall be of the plug-in socket base type, with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals. Relays used for alarm input or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials or engraved switch settings marked in seconds and shall have timing repeatability of ±2 percent of setting. Latching and special purpose relays shall be as needed for the specific application.

f. Terminal Blocks and Panel Wiring. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated, shall be complete with marking strip, covers, and pressure connectors, and shall be labeled to agree with the identification on the temperature control manufacturer's submittal drawings.

   A terminal shall be provided for each conductor of external circuits, plus one ground cable. At least 8 inches [200 mm] of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. At least 25 percent spare terminals shall be provided.

   All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or shall be routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and shall have a space of at least 40 percent of the depth of the duct available for future use after the installation including all field wiring, has been completed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

   Where signal wiring must be routed to more than one panel or device, the requested circuit routing shall be as indicated on the electrical one-line diagrams.

g. Control Power Transformers. Where 24 volt ac control power is necessary for the temperature control components, 120/24 volt transformers shall be furnished and mounted in the respective temperature control panel. Control power transformers shall be sized by the manufacturer based on the equipment load of the panel, shall be copper wound, vacuum impregnated with solid polyester varnish, and shall be 100 percent tested in strict compliance with ANSI, CSA, and UL codes. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded. The control power transformers shall be sized by the manufacturer based on the equipment load of the panel.

h. Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surfaces shall be filled before the surface is painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils [100 µm]. One quart [0.95 L] of paint shall be furnished with the panels for future touchup painting.

2-4.18.05. Dial Thermometers. Not used.

2-4.18.06. Smoke Detectors. Smoke detectors shall be as specified in the Fire Detection and Alarm System section.

2-4.18.07. Pressure Differential Airflow Switches. Pressure differential airflow switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the Drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Switches used for proving airflow shall be selected with the lowest operating range such that the switch activates at 50 percent of the system airflow. Differential switches shall be UL listed.

Where indicated on the Drawings, pressure differential switches shall be provided with an explosion-proof housing suitable for a NEC Class 1, Division 2, Group D environment. Where differential pressure switches are located outdoors, a NEMA 4 rated weather enclosure shall be provided.

Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800". Explosion-proof pressure differential airflow switches shall be Dwyer Instruments, Inc. “Series 1950G”. Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter. The switch shall be spdt, shall be rated 10 amperes at 120 volts ac and for a temperature range of 0°F to 125°F [-18°C to 52°C], and shall be provided with corrosion resistant mounting brackets.

Unless otherwise indicated on the Drawings, initial setpoints of pressure differential switches located across filters shall be 0.75 inch water column [190 Pa] to alarm high filter pressure loss and 0.1 inch water column [25 Pa] when mounted in air systems to alarm ventilation failure.

2-4.18.08. Control Stations. Not used.

2-4.18.09. Emergency Ventilation Shutoff Switches. Not used.

2-4.18.10. Accessory Components. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2-4.18.11. Electrical Wiring. Detailed wiring diagrams shall be submitted in accordance with the Submittals Procedures section. The wiring diagrams shall show the internal connections of the control panels and all field wiring to equipment remote from the control panels including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation.

Control wiring shall be in accordance with the National Electric Code (NEC). Cable shall be multi-conductor, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations.

Conduit for all HVAC control circuits in indoor locations shall be furnished and installed under this section. Conduit type shall be as specified in the Electrical Section.

2-5. ELECTRICAL. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical

section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2-6. DRIVE UNITS. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2-7. MANUFACTURE AND FABRICATION. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2-8. SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2-9. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3-2. PREPARATION.

3-2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3-2.02. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be

performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Architectural Painting and Protective Coatings sections.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Gas fired equipment furnished with pressure regulators that require a vent shall have an independent vent routed to outside. The vent shall be designed to prevent the entry of water or foreign objects.

The space beneath baseplates shall be grouted as specified in the Grouting section.

During construction, control measures as outlined in SMACNA IAQ Guidelines for Occupied Buildings under Construction shall be applied before the operation of any fan system.

All adhesives used on the interior of the building defined as inside the weatherproofing system shall have a VOC content not greater than 80 g/L.

3-3.01. Gas Vents. Gas vents for all equipment exhausting combustible material shall be installed where indicated on the Drawings. Gas vent systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counterflashed to provide a weathertight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

Gas vents shall be supported where indicated on the Drawings and where required by the system manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished and installed at locations determined by the gas vent systems manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

The gas vent heights indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work.

All vertical gas vents shall be equipped with a capped tee to serve as a condensate drain. Vents 6 inches [150 mm] and larger shall be equipped with a condensate drain connection.

Where metal vents are used, each joint shall be sealed with sealant and/or aluminum or Teflon tape suitable for the operating temperatures to prevent leakage. The tape shall be wrapped two full turns around each joint. Where single wall metal vents are used to vent equipment, a double wall vent shall be used outside and shall extend through the wall a minimum of 6 inches [150 mm]. The annular space of the double wall vent shall be sealed at the connection point between the double and single wall pipes. Single wall vents routed through unconditioned spaces or in locations below 8 feet [2.4 m] above the finished floor shall be insulated to prevent condensation or limit the cold face temperature to 150°F [65°C].

Gas unit heater vent shall be installed with a minimum of 12 inches [300 mm] of straight pipe attached to the venter outlet before the installation of an elbow.

3-3.02. Packaged Air Handling Units. Units shall be installed level and with vibration isolators types where indicated on the Drawings. Flexible connections shall not be in tension when the fans are operating. Ductwork and piping installed adjacent to each unit shall not interfere with unit servicing or panel removal.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-3.03. Furnaces. Not used.

3-3.04. Makeup Air Units. Not used.

3-3.05. Heaters. The bottom elevation of unit heaters shall be 8 feet [2.4 m] above finished floor unless otherwise indicated.

Gas fired unit heaters with side burner and control access shall have the access located on the heater side opposite the wall.

3-3.06. Fans. Where indicated on the Drawings, flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

Power roof ventilators shall be secured with corrosion resistant lag screws to the roof curb.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-3.07. Roof Hoods. Not used.

3-3.08. Damper Operators. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

The damper operator shall be installed to prevent entry of moisture from contacting internal parts. Conduit shall enter the operator from below or horizontally and incorporate a drip leg to prevent water from following the conduit into the operator interior.

The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position.

3-3.09. Air Outlet and Inlet Devices. Air outlet and inlet devices shall be installed level and plumb and in accordance with the manufacturer's written instructions. Diffusers with balance dampers installed in the flexible duct takeoffs shall not have an opposed blade damper mounted in the throat of the diffuser. For devices installed in lay-in ceilings panels, the units shall be located in the center of the panel. Ceiling mounted air devices or services weighing 20 pounds [89 N] or more shall be supported directly from the structure.

3-3.10. Draft Gauges. Draft gauges for filters located more than 8 feet [2.4 m] above the finished floor shall be mounted on the nearest wall, 5.5 feet [1.7 m]

above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

3-3.11. Sheet Metal Ductwork. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards unless otherwise indicated. The locations, arrangement, and sizes of ductwork shall be as indicated on the Drawings. The duct sizes

indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch [0.25 kPa].

Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards in accordance with the following:

	Duct Type			
	Supply		Exhaust	Return
Duct Location	≤ 2 inches wc [0.5 kPa]	> 2 inches wc [0.5 kPa]		
Outdoors	A	A	A	A
Unconditioned Areas	B	A	B	B
Conditioned Spaces				
(concealed ductwork)	C	B	B	C
(exposed ductwork)	A	A	B	B

Sealing Levels
- A - All transverse joints, longitudinal seams, and duct wall penetrations
- B - All transverse joints and longitudinal seams
- C - Transverse joints only

All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

Ductwork shall be supported as required by SMACNA. Where ductwork is connected to equipment, it shall be independently supported with no weight bearing on the equipment and in such a manner that the equipment maybe removed for service without temporary support of the ductwork. Ductwork shall be supported within 24 inches [600 mm] of each elbow and within 48 inches [1200 mm] of each branch intersection. Strap or wire hangers shall not be used where the hanger length exceeds 5 feet [1.5 m].

Ductwork shall be constructed and installed in accordance with the Drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet [2.4 m] above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch [200 mm] lighting allowance between the ceiling and the bottom of the ductwork.

In vertical ducts with a closed bottom which terminate less than 24 inches [600 mm] above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch [12.5 mm] drain hole in the bottom of the duct.

Turning vanes shall be installed in all elbows with 45 degree or greater angles. Vanes shall be double thickness or a minimum 4.5 inch [113 mm] radius type for vanes 30 inches [762 mm] and longer, where installed in ducts with velocity greater than 2000 fpm [10 m/s], or where installed in ducts with a pressure classification greater than 2 inches wc [0.5 kPa]. Where 4.5 inch [113 mm] or double thickness type turning vanes are required, each vane shall be welded to the vane runner.

Sheet metal ductwork designed and indicated to operate at pressures greater than 3 in wc [0.75 kPa] shall be leaked tested according to SMACNA Duct Leakage Test Procedures. Representative sections of duct totaling not less than 25 percent of the total installed duct area for the designated pressure class shall be tested.

3-3.12. Duct Insulation. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces which are to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall have the manufacturer's stamp or label bearing the name of the manufacturer and description of the contents.

Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches [200 mm] on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

The following ducts shall be insulated with interior duct liner unless indicated on the Drawings to be wrapped or otherwise indicated:

Location	Ductwork	Insulation Thickness
Exterior	a. All ductwork	2 inches [50 mm]
Interior within conditioned space (heated or cooled)	a. Heating supply and return	1 inch [25 mm]
	b. Cooling supply and return	1 inch [25 mm]
	c. Heating and cooling supply and return	1 inch [25 mm]
	d. Makeup air outside area served	1 inch [25 mm]
	e. Outside air (including plenums)	1.5 inches [37 mm]
Interior within unconditioned space	a. Heating supply and return	1.5 inches [37 mm]
	b. Cooling supply and return	1.5 inches [37 mm]
	c. Heating and cooling supply and return	1.5 inches [37 mm]
	d. Makeup air outside area served	1.5 inches [37 mm]
	e. Outside air (including plenums)	2 inches [50 mm]
Note: Exhaust systems shall not be internally lined.		

3-3.13. Flexible Duct and Takeoffs. The length of the flexible ductwork shall not exceed 8 feet [2.4 m]. All support saddles for flexible duct shall be a minimum of 6 inches [150 mm] wide.

3-3.14. Access Doors. Airtight access doors shall be provided for inspection of all dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the Drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches [200 mm] square for hand access, 18 inches [450 mm] for shoulder access, or as indicated on the Drawings. Each access door shall be installed to open against the pressure in the duct.

Access doors shall be installed to allow for inspection, cleaning, and maintenance of the ductwork. Doors shall be installed on each side of elbows with turning vanes and along the duct at a maximum 50 foot [15 m] spacing.

3-3.15. Temperature Controls. Automatic temperature controls shall be furnished and installed as indicated on the Drawings and as specified herein.

Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the Drawings. Control equipment shall be installed with adequate space for operating and maintenance access.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-3.15.01. Temperature Control Panels. Not used.

3-3.15.02. Thermostats. Wall-mounted thermostats shall be mounted above the finished floors as indicated in the Electrical section. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

Wall-mounted thermostats in non air-conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. Where an installation check by the manufacturer is specified in the equipment installation paragraphs above, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-4.02. Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3-5. CLEANING. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

Upon completion of the duct system cleaning, the duct system shall be visually inspected for cleanliness to verify no visible contaminants are present to the satisfaction of Engineer. If the visual inspection is inconclusive, then additional tests in accordance with the National Air Duct Cleaners Association shall be performed. Any ducts that are considered not to be clean by the ENGINEER shall be re-cleaned and re-tested. Any damaged materials or surfaces shall be repaired or replaced. A report shall be provided indicating the successful cleaning of the ductwork, method used to determine the cleanliness, and results of any tests.

End of Section

Section 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1-1. SCOPE. This section covers the cleaning, testing, adjusting, and balancing of the air system(s) associated with the heating, ventilating, and air conditioning (HVAC).

1-2. GENERAL. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.

Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

1-2.02. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of airsystems.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete apparatus report sheets for all air systems shall be accurately and completely filled out in accordance with the Standard's manual. The testing and balancing results shall be submitted on the TAB report forms of the applicable standard. Copies of the final test readings and report sheets shall be submitted in accordance with the Submittals Procedures section. A description of the standard procedures used during testing, adjusting, and balancing shall be included in the submittal. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets. Test dates shall be recorded on the individual TAB report forms indicating when the actual testing was performed.

The apparatus report sheets shall include the following information:

1. Title Page:
    a. Company name
    b. Company address
    c. Company telephone number
    d. Project name
    e. Project location
    f. Project Engineer
    g. Project Contractor
    h. Project altitude
    i. Date
2. Instrument List:
    a. Instrument
    b. Manufacturer
    c. Model
    d. Serial number
    e. Range
    f. Calibration date
3. Air Moving Equipment:
    a . Unit number
    b. Location
    c. Manufacturer
    d. Model and serial number
    e. Airflow, design and actual
    f. Total static pressure (total external), design and actual
    g. Static pressure, inlet and discharge
    h. Total pressure
    i. Fan RPM, design and actual
4. Electric Motors:
    a. Manufacturer
    b. Motor type and frame
    c. HP/BHP
    d. Phase, voltage, amperage, nameplate, actual, no load.
    e. RPM
    f. Service factor
    g. Starter size, rating, heater elements
5. V-Belt Drive:
    a. Required driven RPM
    b. Driven sheave make, diameter, and RPM
    c. Belt make, size, and quantity
    d. Motor sheave make, diameter, and RPM
    e. Center to center distance, maximum, minimum, and actual
6. Return Air/Outside Air Data:
    a. Unit number

b. System airflow, design and actual
c. Return airflow, design and actual
d. Outside airflow, design and actual
e. Return air temperature
f. Outside air temperature
g. Mixed air temperature, design and actual
h. Outside/return air ratio, design and actual

7. Coil Data:
   a. Unit number
   b. Location
   c. Service
   d. Manufacturer
   e. Fin spacing and rows
   f. Face area
   g. Airflow, design and actual
   h. Air velocity, design and actual
   i. Entering air DB temperature, design and actual
   j. Entering air WB temperature, design and actual
   k. Leaving air DB temperature, design and actual
   l. Leaving air WB temperature, design and actual
   m. Water flow, design and actual
   n. Water pressure drop, design and actual
   o. Entering water temperature, design and actual
   p. Leaving water temperature, design and actual
   q. Air pressure drop, design and actual
8. Duct Traverse:
   a. System zone/branch
   b. Duct size
   c. Area
   d. Velocity, design and actual
   e. Airflow, design and actual
   f. Duct static pressure
   g. Air temperature
   h. Air correction factor
9. Outlet and Inlet Devices:
   a. Air outlet and inlet device number
   b. Room number/location
   c. Air outlet and inlet device type
   d. Air outlet and inlet device size
   e. Area factor
   f. Velocity, design, preliminary, and final
   g. Air flow, design, preliminary, and final
   h. Percent of design airflow
10. Sound Level Report:
    a. Location

b. Octave bands - equipment off
c. Octave bands - equipment on

11. Package Air Conditioning/Heat Pump Unit.
    a. Unit number
    b. Location
    c. Manufacturer and model
    d. Refrigerant type and capacity
    e. Airflow, design and actual
    f. Return airflow, design and actual
    g. Outside airflow, design and actual
    h. Dry bulb temperature, entering and leaving
    i. Wet bulb temperature, entering and leaving
    j. Outside air temperature, dry and wet bulb
12. Air Terminal Unit Data:
    a. Manufacturer
    b. Type, constant, variable, single
    c. Unit number
    d. Location
    e. Model
    f. Size
    g. Minimum static pressure
    h. Minimum design airflow
    i. Maximum design airflow
    j. Maximum actual airflow
    k. Inlet static pressure
13. Electric Duct Heater: Not used.
14. Air Cooled Condenser/Heat Pump/VRF:
    a. Unit number
    b. Location
    c. Manufacturer and model
    d. Refrigerant type and capacity
    e. Entering DB air temperature, design and actual
    f. Leaving DB air temperature, design and actual
    g. Number of compressors
    h. Suction pressure and temperature
    i. Condensing pressure and temperature
15. Chillers: Not used.
16. Pump Data: Not used.
17. Heat Exchanger: Not used.
18. Combustion Test: Not used.

Product data indicating cleaning materials and treatment, chemicals, and reports on the analysis of system water after cleaning and after treatment, shall be submitted in accordance with the Submittals Procedures section.

1-4. QUALITY ASSURANCE. Contractor shall provide the services of a licensed independent contractor, certified by AABC, NEBB, or TABB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air systems. The work shall be performed in accordance with the latest edition of the procedural standards as published by the National Organization associated with the testing, adjusting, and balancing contractor.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the equipment sections.

2-2. CONSTRUCTION.

2-2.01. Painting. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Architectural Painting and Protective Coatings sections.

PART 3 - EXECUTION

3-1. INSPECTION. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Dampers shall be open and access doors and panels shall be closed during the testing and balancing period.

A resistance shall be placed at all filter locations to simulate dirty filter conditions. The filter resistance shall be as follows:

Filter Type	Simulated Loss
1 inch [25 mm] pleated	0.15 inch water column [37 Pa]
2 inch [50 mm] pleated	0.35 inch water column [87 Pa]

3-2. STARTUP REQUIREMENTS. System equipment shall be subject to preliminary field tests as indicated in Startup Requirements section.

3-3. FIELD PERFORMANCE TESTING. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and

tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

Filter Type	Dirty Filter Conditions
1 inch [25 mm] pleated	0.75 inch water column [186 Pa]
2 inch [50 mm] pleated	1 inch water column [250 Pa]

3-3.01. Hydronic Piping. Not used.

3-3.02. Refrigerant Piping. The refrigerant piping system shall be tested in accordance with ANSI/ASME B31.5.

After testing of the refrigerant piping system is completed, the system shall be charged with the proper refrigerant and placed in operation.

The completed refrigerant system shall be guaranteed to be sufficiently free from leaks for 1 year from the date of acceptance. The loss of refrigerant shall not exceed 5 percent over that period.

3-4. CLEANING. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3-4.01. Chemical Pipe Cleaning. Not used.

3-5. ADJUSTING & BALANCING. The air system shall be adjusted and balanced.

All instrumentation shall be calibrated in accordance with the governing standard manual and shall be checked for accuracy before testing, adjusting, and balancing the systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.

All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.

Following final acceptance of the certified balancing reports, the testing and balancing contractor shall permanently mark the settings of all adjustment devices, including valves and dampers, and shall lock the memory stops.

All ceiling tiles, belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.

3-5.01. Air Systems. Air systems shall be adjusted to the design airflows indicated on the Drawings. Airflows shall be adjusted to maintain a net positive (supply airflow greater than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the Drawings. Dampers located behind air outlet and inlet devices shall be used to adjust the airflow only to the extent that the adjustments do not create objectionable air movement or noise. Fans shall not be adjusted above the maximum safe speed as determined by the fan manufacturer.

Dampers with operators shall be checked for tight shutoff when in the closed position. Shutoff dampers shall not be used for balancing.

End of Section

Section 23 09 11

BUILDING SYSTEM CONTROLS

PART 1 - GENERAL

1-1. SCOPE. This section covers the design, furnishing, and installation of control systems and instrumentation associated with the heating, ventilation, and air conditioning (HVAC) equipment and systems including all associated equipment, devices, and controls necessary for proper operation.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

All software and documentation developed for the project building system controls shall become the property of the Owner upon completion of the project. These include but are not limited to system documentation, project graphic images, project database, record drawings, and specific project application programming code.

1-2.01. Coordination. The control and instrumentation shall be designed and coordinated for proper operation with the controlled equipment and materials furnished under other sections, under other contracts, and with related existing equipment. All controls devices and instruments shall be applied in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the device manufacturer and controlled equipment manufacturer unless exceptions are noted by Engineer.

Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment or instrumentation are needed, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Contractor shall provide coordination with the other contractors and supervision of installation as needed during construction. This includes products furnished but not necessarily installed, products installed but not necessarily furnished, and products not furnished and installed but integrated with the building control systems.

Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. The temperature controls supplier shall design and furnish a complete and functional control system in accordance with the Drawings, specifications, and sequence of operation. The control wiring shall be furnished and installed as described herein so that all HVAC equipment will function as described in the HVAC sequence of operation

Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper and valve actuators, temperature/digital control panels, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the cable and raceways paragraph. Cable and conduit for all HVAC power circuits shall be as specified in the Electrical section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.

Motor starters will be provided with terminal blocks for the termination of conductors for operational control and run/off status of the equipment. Refer to the electrical schematics for additional information.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

When indicated by the applicable codes, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing organization acceptable to the governing authority.

1-2.04. Power Supply. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or necessary for a properly operating system.

1-2.05. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.06. Mechanical Identification. Mechanical identification for equipment, control devices, piping, valves, and ductwork shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-2.07. Lubrication. Lubrication shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, power wiring, control wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications shall include, but shall not be limited to, the following:

a. Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.

b. Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring and instrument piping with all terminals and ports accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

c. Not used.

d. Written sequence of operation for each system corresponding to the control schematics.

e. Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

f. Space thermostat schedule indicating the types of covers and means of adjustment for each space.

g. Conduit and wire types.

h. Data for DDC system hardware, software, and architecture including schematic diagrams for all control, communication, and power wiring. The schematic diagrams shall indicate how each device is wired and powered and include a schematic flow diagram with air and water system components and control devices.

i. A point list for each system controller including both physical inputs and outputs along with virtual points. The list shall include the name, scanning frequency, units, default value, alarm values and alarm differentials to return to normal condition, massage and alarm report, and description.

j. A list of color graphic screens indicating the conceptual layout of pictures and data to be available at the operator terminal.

1-3.02. Operations and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

1-4. QUALITY ASSURANCE. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-4.01. Contractors Qualification. The entire system shall be designed, coordinated, and supplied by a qualified Contractor who is regularly engaged in the business of designing and building instrument and control systems for heating, ventilating, and air conditioning equipment. The Contractor shall have at least 5 years of documented experience in designing and installation of the products specified and shall be employed by the control manufacturer or be an approved certified installer with full responsibility for proper operation of the control including startup and calibration of each component in the controls system.

1-4.02. Tolerances. Unless otherwise indicated, the controls shall maintain space temperatures within ±2°F [1.1°C], and the relative humidity within ±5 percent of the setpoint.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

1-6. EXTRA MATERIALS. Not used.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. A complete system of automatic temperature controls shall be furnished and installed to accomplish the control described in the sequence of operations. All control equipment shall be compatible for operating with the control system provided.

The control system shall consist of all necessary thermostats, control valves, switches, relays, timers, and gauges in accordance with the sequence of operation indicated on the Drawings. Technical engineering services, including but not limited to engineering, programming, installation supervision, commissioning, and troubleshooting shall be provided for a complete and functional system.

2-2.01. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet [610 m] above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2-3. ACCEPTABLE MANUFACTURERS. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; Andover Controls; or Siemens Building Technologies, Landis Division. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2-4. MATERIALS. All products used shall be new and part of the manufacturer's current product line. Materials shall be supported for at least 5 years after completion with extra materials available.

2-4.01. Electric/Electronic Control Systems. Electric/electronic control systems shall be furnished and installed as indicated on the Drawings and specified herein.

2-4.01.01. Thermostats. Thermostats specified in the individual equipment paragraphs shall be provided with the respective equipment.

a. Two Position Wall Mounted Thermostats. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch", Penn Controls "A19BAC-1", or Siemens Building Technologies.

   Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F [2°C to

38°C] with a nonadjustable differential of 3.5°F [2°C]. The thermostats shall have a spdt switch rated for 1 horsepower [0.746 W].

b. Two Position Corrosion Resistant Wall Mounted Thermostats. Not used.

c. Two Stage Wall Mounted Thermostats. Not used.

d. Low Limit Thermostats. Not used.

e. Remote Bulb Thermostats. Not used.

f. Modulating Wall Mounted Thermostats. Modulating, wall mounted thermostats shall be Honeywell "Model T92", or Penn Controls "Model T80ABA-1", or Siemens Building Technologies.

   Modulating, wall mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have a operating range of approximately 63°F to 87°F [17°C to 31°C] with a throttling range of approximately 1.5°F to 6.5°F [0.8°C to 3.6°C].

g. Modulating Duct Mounted Thermostats. Not used.

h. Explosion-Proof Thermostats. Not used.

i. Electromechanical Wall Mounted Thermostats. Not used.

j. Programmable Wall Mounted Thermostats. Programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45°F to 95°F [7°C to 35°C] with the following features:

   - 7 day programming with 2 occupied/unoccupied periods per day.
   - Automatic heat/cool changeover.
   - Battery backup.
   - Setback controls to automatically restart and temporarily operate system during setback periods.
   - Digital display.
   - Temporary override of setpoints.
   - 2 configurable LED's.
   - Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

k. Humidistats. Not used.

2-4.01.02. Economizer Control System. Not used.

2-4.02. Direct Digital Control Systems. Not used.

2-4.03. Temperature Control Panels. Not used.

2-4.04. Temperature Indicators. Not used.

2-4.04.01. Dial Thermometers. Not used.

2-4.04.02. Electronic Temperature Transmitters. Not used.

2-4.05. Smoke Detectors. Smoke detectors shall be as specified in the Fire Detection and Alarm System section.

2-4.06. Pressure Differential Switches. Not used.

2-4.07. Water Flow Switches. Not used.

2-4.08. Control Stations. Not used.

2-4.09. Emergency Ventilations Shutoff Switches. Not used.

2-4.10. Control Valves. Not used.

2-4.11. Accessory Components. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2-5. CONSTRUCTION.

2-5.01. Shop Painting. Unless otherwise indicated, shop painting shall be as specified in the General Equipment Stipulations. Surface finish damaged during installation shall be repaired to the satisfaction of the Engineer. Field painting shall conform to the requirements of the Protective Coating section.

2-6. CABLE AND RACEWAYS.

2-6.01. Cable. Cable used in the temperature control system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations. All cable necessary for the system, except 120 volt ac power, shall be furnished and installed by the System Supplier.

2-6.02. Raceways. All cable shall be installed in conduit furnished under this section. Conduit materials shall conform to the applicable paragraphs of the Electrical section.

2-7. ELECTRICAL. All electrical controls shall have enclosures suitable for the

environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2-8. MANUFACTURE AND FABRICATION. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3-2. PREPARATION.

3-2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3-2.02. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Architectural Painting and Protective Coatings sections.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Contractor shall be responsible for determining that all equipment supplied is

suitable for installation in the space indicated on the Drawings. Control equipment shall be installed with adequate operating and maintenance access space.

3-3.01. Temperature Control Panels. Not used.

3-3.02. Thermostats. Wall-mounted thermostats shall be mounted above the finished floors as indicated in the Electrical section. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

Wall-mounted thermostats in non-air conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3-3.03. Device Tag Numbering System. All devices shall be provided with permanent identification tags numbered to agree with the manufacturer's equipment drawings. All field-mounted control devices shall bear securely fastened identification tags. Hand-lettered labels or tape will not be acceptable.

Phenolic nameplates shall be provided and permanently attached to the wall at each control device to indicate the equipment controlled. The letters used shall be the same as the equipment designations indicated herein and on the Drawings. Nameplates shall have white letters on black backgrounds.

3-3.04. Control Valves. Not used.

3-3.05. DDC System. Controllers shall be mounted in accordance with manufacturer’s installations. All software shall be installed, initialized, programmed, and tested. System point names shall be modular in design with location, system, identification, and action represented, allowing easy operator interface without the use of a written point index.

3-3.06. Cable. Cable shall be installed in conduit as described in the cable installation paragraphs in the Electrical section. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

3-3.07. Raceways. Conduit shall be installed as described in the conduit installation paragraphs in the Electrical section.

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. An experienced, competent, and authorized representative of the temperature controls supplier shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation.

The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-4.02. Field Testing. After the installation of the equipment and systems has been completed, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

3-5. ADJUSTING. The building system controls supplier shall provide initial startup and adjustment of the control systems, and setpoint maintenance for one year.

The building system controls supplier shall be responsible for establishing the final control system settings necessary for proper operation of the equipment and systems. These settings and calibration shall have the concurrence of the equipment manufacturer's representative.

The building system controls supplier shall demonstrate to Owner the complete and correct functioning of all control systems and equipment, and shall make all necessary repairs, replacements, or adjustments to items which fail to perform to the satisfaction of the Owner.

3-6. CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to the Owner.

3-7. OPERATOR INSTRUCTION AND TRAINING. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided as required. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

a. Documentation in the final Operation and Maintenance Manuals.
b. Use the Operation and Maintenance Manuals.

c. Equipment and system startup and shutdown.

d. System operation procedures for all modes of operation.

e. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

Section 23 50 11

HEATING SYSTEMS EQUIPMENT

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of heating system equipment and associated devices and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

[Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable

municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1-2.05. Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1-2.06. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment
- Name of manufacturer.
- Type and model.
- Construction materials, thicknesses, and finishes.
- Manufacturer's performance data.
- Overall dimensions and required clearances.
- Net weight and load distribution.
- Wiring diagrams.
- Locked rotor current.

Seismic Design Requirements
- Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

Data for the burner and boiler shall be submitted together.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals

Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. QUALITY ASSURANCE. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Equipment capacities shall be as indicated on the schedules.

Gas fired equipment shall be suitable for operation with the gas inlet pressure range specified in the individual equipment paragraphs.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet [0.9 m] of clear access space shall be provided on all sides of the unit unless otherwise indicated.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation as indicated on the Drawings.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MATERIALS.

2-4.01. Gas Vent Systems. Gas vent systems shall be provided for all equipment that exhausts combustible material. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Gas vent system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions and to any local codes which pertain to such work.

Factory built gas vent piping and fittings shall be laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211. The materials and construction of the modular sections shall meet the terms of the product UL listing.

2-4.01.01. Category I Factory Built Gas Vents. Factory built gas vent systems for category I vented equipment shall be Selkirk Metalbestos or Metal-Fab, "Type B" gas vents.

The gas vents shall be of double wall construction, with at least a 0.25 inch [6 mm] air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.012 inch [0.3 mm] aluminum and the outer jacket of at least 0.018 inch [0.5 mm] galvanized steel.

2-4.01.02. Category II, III, and IV Factory Built Gas Vents. Gas vent systems for category II, III, and IV unit heaters with vents 5 inch [125 mm] and smaller shall be Selkirk Metalbestos "Model DCV" or Heat-fab special gas vent. The vent pipe and fittings shall be of double wall construction with a nominal 0.5 inch [13 mm] air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.016 inch [0.4 mm] AL29-4C stainless steel and the outer jacket shall be constructed of at least 0.016 inch [0.4 mm] Type 304 stainless steel.

Chimney and vent systems for category II, III, and IV equipment with vents 6 inch [150 mm] and larger shall be Selkirk Metalbestos "Type PS" gas vent or Metal Fab "Model PIC". The vent pipe and fittings shall be of double wall construction with a nominal 1 inch [25 mm] air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch [0.9 mm] AISI Type 316 stainless steel and the outer jacket shall be constructed of at least 0.024 inch [0.6

mm] aluminum coated steel for interior locations and AISI Type 316 stainless steel for the portions of the stack exposed to the outdoor environment.

2-4.01.03. Metal Gas Connectors. Metal gas vents shall be used indoors where the gas vent is not directly connected to the equipment shall be constructed of at least 20 gage [0.91 mm] thickness galvanized steel. The connector shall be sized and arranged as recommended by the vented equipment manufacturer or as directed by Engineer. The gas vent system shall include all necessary fittings, hangers, supports, and flashings.

2-4.02. Gas-Fired Heating Water Boilers. Not used.

2-4.03. Heaters. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the Drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2-4.03.01. Baseboard Heaters. Not used.

2-4.03.02. Cabinet Heaters. Not used.

2-4.03.03. Heating Water Convectors. Not used.

2-4.03.04. Electric Duct Heaters. Not used.
2-4.03.05. Electric Infrared Heaters. Not used.

2-4.03.06. Electric Unit Heaters. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the Drawings.

a. Electric Unit Heaters (heavy-duty). Electric unit heaters located in unclassified areas shall be Chromalox "LUH", or Brasch. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the Drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the Drawings to be wall hung, a wall mounting bracket shall be provided.
b. Electric Unit Heaters (explosionproof). Not used.
c. Electric Unit Heaters (corrosion resistant). Not used.

2-4.03.07. Gas Unit Heaters. Gas unit heaters, denoted by the symbol "GUH" and an identifying number, shall be Sterling “GG", Trane “GT” or “GH”, or Modine

“HD” or “PDP”. Gas unit heaters shall be designed for use with natural gas at a pressure range of 10 -14 inches w.c. [2.5-3.5 kPa]. Each unit shall have a combustion efficiency of at least 80 percent.

Gas unit heaters shall be furnished and installed where indicated on the Drawings. Each heater shall be of the type, size, and capacity indicated in the schedules on the Drawings; shall be suitable for use with the gas type and pressure as required; and shall be independently listed and certified to conform with the latest ANSI Standards for the safety and efficiency performance.

Each gas-fired unit heater shall be low profile, power vented, horizontal discharge, propeller type, and suitable for suspending mounting as indicated on the Drawings. The tubular heat exchanger shall be constructed of E-3 (AISI Type 409) stainless steel. Each heater shall be furnished with a vent cap.

Each heater shall be capable of operating with conventional vertical or horizontal venting with up to 20 feet [6.1 m] of straight venting system plus an additional allowance for at least two 90 degree elbows and a termination cap.

Each gas unit heater shall be furnished complete with a 24 volt transformer, single-stage gas control with a regulated combination redundant gas valve, spark-ignition system with electronic flame supervision, and all required limit and safety controls. Units larger than 125,000 Btu [132,000 kJ] input shall have two-stage gas controls.

The fan motor shall be suitable for use with a 120 volt, 60 Hz, single phase power supply, and shall be provided with automatic reset thermal overload protection.

2-4.03.08. Heating Water Unit Heaters. Not used.

2-4.03.09. Wall Heaters. Not used.

2-5. ELECTRICAL. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2-6. DRIVE UNITS. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2-7. MANUFACTURE AND FABRICATION. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2-8. SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2-9. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 – EXECUTION

3-1. INSPECTION. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3-2. PREPARATION.

3-2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3-2.02. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint

manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Gas fired equipment furnished with pressure regulators that require a vent shall have an independent vent routed to outside. The vent shall be designed to prevent the entry of water or foreign objects.

3-3.01. Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body.

3-3.02. Gas Vents. Gas vents for all equipment exhausting combustible material shall be installed where indicated on the Drawings. Gas vents systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counterflashed to provide a weathertight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

Gas vents shall be supported where indicated on the Drawings and where required by the system manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished and installed at locations determined by the gas vent systems manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

The gas vent heights indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work.

All vertical gas vents shall be equipped with a capped tee to serve as a condensate drain. Flues 6 inches [150 mm] and larger shall be equipped with a condensate drain connection.

Where metal gas connectors are used, each joint shall be sealed with sealant and/or aluminum or Teflon tape suitable for the operating temperatures to prevent leakage. The tape shall be wrapped two full turns around each joint. Single wall flues routed through unconditioned spaces or in locations below 8 feet [2.4 m] above the finished floor shall be insulated to prevent condensation or limit the cold face temperature to 150°F [65°C].

Gas unit heater flues shall be installed with a minimum of 12 inches [300 mm] of straight pipe attached to the venter outlet before the installation of an elbow.

3-3.03. Gas Heating Water Boiler. Not used.

3-3.04. Heaters. The bottom elevation of unit heaters shall be 8 feet [2.4 m] above finished floor unless otherwise indicated.

Gas fired unit heaters with side burner and control access shall have the access located on the heater side opposite the wall.

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. An installation check by an authorized representative of the manufacturer is not required for equipment specified in this section.

3-4.02. Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

Initial startup of the boilers, including all burner equipment and burner controls, shall be provided through a qualified manufacturer's representative who shall record all burner and control settings. Copies of the records shall be made available to Engineer prior to acceptance of the equipment.

3-5. CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner. Each boiler shall be

thoroughly cleaned in accordance with the manufacturer's instructions prior to being placed in service.

End of Section

Section 23 70 00

REFRIGERATION SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of refrigerant piping and accessories, heat pumps, package heat pumps, ductless split systems, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1-2.01. Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1, unless otherwise indicated on the Drawings.

Capacity ratings for condensing units, heat pumps, packaged air conditioning units, and packaged heat pumps with capacities less than 135,000 BTUH [39 kW] shall be in accordance with AHRI Standard 210/240. For condensing units, heat pumps, packaged air conditioning units and packaged heat pumps with capacities over 135,000 BTUH [39 kW] the capacity ratings shall be in accordance with AHRI Standard 340/360.

1-2.05. Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

1-2.06. Metal Thickness. Metal thickness and gauges specified herein are minimum requirements. Gauges refer to US Standard gauge.

1-2.07. Mechanical Identification. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Refrigerant Piping

Schematic arrangement showing equipment, coils, piping sizes, valves, and accessories.

A refrigerant piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction.

Multi Split Variable Refrigerant Flow System Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Equipment efficiency ratings.

Refrigerant type and charge.

Overall dimensions and required clearances.

Multiline wiring diagrams clearly indicating field installed and factory installed wiring with all terminals identified.

Electrical requirements including voltage, number of phases, and

amperage.

Net weight and load distribution.

Where specified, information on equipment manufacturers' representatives.

Room Air Conditioners

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Wiring diagrams and electrical requirements.

Net weight.

Where specified, information on equipment manufacturers' representatives.

Packaged Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Net weight and load distribution.

Multiline wiring diagrams clearly indicating field installed and factory installed wiring with all terminals identified.

Electrical requirements including voltage, number of phases, and amperage.

Where specified, information on equipment manufacturers' representatives.

Ductless Split System Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Location and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Multiline wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Where specified, information on equipment manufacturers' representatives.

Wall Air Conditioning Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Net weight and load distribution.

Multiline wiring diagrams clearly indicating field installed and factory installed wiring with all terminals identified.

Electrical requirements including voltage, number of phases, and amperage.

Where specified, information on equipment manufacturers' representatives.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1-4. QUALITY ASSURANCE. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

1-6. EXTRA MATERIALS. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

For equipment including fans, each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2-2.01. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet [0.9 m] of clear access space shall be provided on all sides of the unit unless otherwise indicated.

2-2.02. Elevation. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet [610 m] above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-4. MATERIALS.

2-4.01. Refrigerant Piping and Accessories. Refrigerant piping shall conform to the Copper Tubing and Accessories section. Piping shall be supported as specified in the Pipe Supports section. Refrigerant filter dryers, expansion valves, solenoid valves, combination sight glass and moisture indicators, charging valves, relief valves, and other accessories shall be furnished and installed as needed for proper operation of the system.

2-5. EQUIPMENT.

2-5.01. Heat Pumps. Heat pumps denoted by the symbol "HP" and an identifying number, shall be furnished and installed where indicated on the Drawings. Each unit shall consist of compressor(s), condenser coil, condenser fan(s) and motor(s), starters, and all controls necessary for proper operation. Condensing units and heat pumps shall be manufactured by LG, Trane, Carrier, Diakin, or York.

The manufacturer of the equipment provided shall have a local service center.

2-5.01.01. Extra Materials. Not used.

Extra Materials	Quantity
Complete change of lubricating oil	1

2-5.01.02. Performance and Design Requirements. Each unit shall be completely factory assembled and tested, piped, internally wired, and shipped in one piece. Each unit shall be fully charged with R-410A and compressor oil. Condensing units and heat pumps shall be selected to satisfy the cooling and cooling/heating requirements of the air handling unit being served. A 2°F [1°C] suction temperature difference for piping losses shall be allowed between the condensing unit or heat pump and the air handling unit when in the cooling mode.

Heat pumps shall be capable of satisfactory cooling operation at the maximum and minimum outdoor ambient air temperatures indicated on the Drawings. When units are indicated to operate in the cooling mode at a lower temperature than the factory standard as indicated in the schedules on the Drawings, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F [-18°C] consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature. Heat pumps shall be capable of operating satisfactorily at an ambient air temperature of 0°F [-18°C] in the heating mode.

Heat pumps shall be designed to operate on the power supply as indicated on the Drawings.

Where indicated in the schedules on the Drawings, all copper and other unit surfaces subject to corrosion from the atmosphere indicated shall be given a special coating.

2-5.01.03. Casing. The unit casing shall be of weatherproof design, constructed of heavy gauge galvanized or zinc-coated steel, and reinforced and braced for maximum rigidity. All bracing and reinforcing members shall be integral to each unit. The casing shall be given a factory-applied coat of rust-inhibitive universal primer, followed by the manufacturer's standard baked enamel finish. Fasteners shall be stainless steel or coated for corrosion protection. Each unit shall have

removable panels or access doors for access to all components and connections. Drainage holes shall be located in the base section for moisture removal. The unit shall be supported above the mounting surface with base rails or feet.

2-5.01.04. Outdoor Coils. Outdoor coils shall be of the air-cooled, finned tube type with liquid accumulator and integral subcoolers. The coils shall be constructed of 3/8 inch [10 mm] OD seamless copper tubing with aluminum fins securely bonded to the surface. Coils shall be factory leak and pressure tested at 425 psig [2930 kPa gauge] and then completely dehydrated and sealed with a holding charge of nitrogen or refrigerant. The coils shall be protected from hail damage by louvered metal grilles or on units 5 tons or less, corrosion resistant wire maybe used.

2-5.01.05. Fans and Motors. Outdoor fans shall be vertical discharge, direct-driven propeller type, and shall be statically and dynamically balanced. Fan guards shall be located on the discharge of each fan. Fan motors shall be totally enclosed suitable for outdoor installation and shall have permanently lubricated ball bearings and built-in overload protection.

2-5.01.06. Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Where the compressors are located outside the cabinet, grilles shall be installed over the openings to protect the compressor area. Each condensing unit/heat pump shall have a minimum number of capacity reduction steps as indicated in the schedules on the Drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2-5.01.07. Refrigerant Circuit and Accessories. Each refrigerant circuit shall be equipped with filter-dryer and multiuse liquid and gas line valves. The multiuse valves shall be constructed of brass with service pressure gauge ports. For condensing units and heat pumps larger than 20 tons [70.3 kW], factory mounted suction and discharge pressure gauges shall be provided. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

Heat pumps shall be provided with reversing valve, flow control check valve, and solid state defrost control system. The defrost system shall be a time and temperature initiated system that activates in response to a temperature sensing element mounted at the outdoor coil.

2-5.01.08. Controls. Condensing units and heat pumps shall be completely factory wired for a single point power supply connection and unit mounted disconnect switch. All wiring shall be installed in accordance with the National Electrical Code.

Condensing units and heat pumps 5 tons [17.5 kW] or less shall be provided with factory wired control panel containing magnetic contactors, relays, and control power transformer. Units larger than 5 tons [17.5 kW] shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor and outdoor fan motors and internal control power transformer.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously. The control system shall prevent the operation of the auxiliary heat when the heating load can be met by the heat pump alone.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat, supply voltage terminal points for remotely located refrigerant solenoid valves, and terminal points to energize remote condensing unit and heat pump indicating lights.

A normally open dry contact that closes on any alarm condition except low refrigerant suction pressure, shall be furnished.

2-5.02. Room Air Conditioner.

2-5.03. Packaged Heat Pump Units. Packaged heat pumps denoted by the symbol "PHP" and an identifying number shall be furnished and installed where indicated on the Drawings. Each unit shall be designed for outdoor installation on a full perimeter curb as indicated on the Drawings. The packaged air conditioning unit/heat pump shall be manufactured by Trane, Carrier, Diakin, or York.

The manufacturer of the equipment provided shall have a local service center.

2-5.03.01. Extra Materials.

Extra Materials	Quantity
Complete changes of lubricating oil	1
Sets of air filters	2

2-5.03.02. Performance and Design Requirements. The units shall be completely factory assembled and tested, piped, internally wired, fully charged with R-410A and compressor oil, and shipped in one piece. The unit shall be designed for direct expansion cooling and configured for heating type indicated.

The unit shall be suitable for the power supply and shall have the capacities indicated on the Drawings. Cooling capacities listed in the schedule are gross cooling capacity.

The refrigeration system shall be capable of satisfactory cooling operation at the maximum and minimum outdoor ambient air temperatures indicated on the Drawings. In addition, heat pumps shall be capable of satisfactory heating operation at the outdoor ambient temperature indicated on the Drawings. Where units need to operate in the cooling mode at a lower temperature than the factory standard as indicated in the schedules on the Drawings, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F [-18°C] consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature.

Where indicated in the schedules on the Drawings, all copper and other surfaces subject to corrosion from the atmosphere indicated shall be given a special coating.

2-5.03.03. Casing. The unit casing shall be of weatherproof design and shall be constructed of 20 gage [0.91 mm] or heavier zinc-coated steel. The casing shall be properly reinforced and braced for maximum rigidity. The casing shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard baked enamel finish. Interior surfaces of exterior casing members in contact with the airstream shall have 1 inch [25 mm] thick, 1 pound [454 kg] density, insulation coated on the air side. Aluminum foil-faced

glass fiber insulation shall be used in gas fired heating sections. Hinged, insulated, neoprene gasketed access doors or removable panels shall be provided to permit easy inspection and maintenance. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1. Removable insulated access panels shall have aluminum or steel covering on the interior to protect the insulation. The unit base shall be a one-piece, welded assembly with suitable roof curb sealing gasket and curb overhang for water runoff. Drains shall be provided to accommodate outdoor coil runoff.

2-5.03.04. Indoor Coil Section. The indoor coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory leak tested underwater at 200 psig [1380 kPa gauge]. The coil shall be provided with expansion device or valve, filter-dryer, and moisture indicator. The indoor coil section shall have fully insulated, sloped drain pan extending under the entire coil section and extending sufficiently past the coil to capture and collect any condensate carryover that may be produced when the unit is operating within the specified operating conditions. The drain pan construction shall comply with the requirements of ASHRAE 62.1.

2-5.03.05. Heating Sections. The unit shall have heating section of the type scheduled on the Drawings.

Electric coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code. The heating coil shall have the minimum number of stages indicated in the schedules on the Drawings.

2-5.03.06. Filters. Filters shall be mounted integral within the packaged air conditioning or heat pump unit and shall be 2 inches [50 mm] thick. Hinged access doors shall be provided. Filters shall conform to the requirements in the Heating, Ventilating, and Air Conditioning Systems section or Air Distribution Systems section.

2-5.03.07. Fans and Motors. The indoor supply fan shall be forward-curved, multiblade, centrifugal type and shall be statically and dynamically balanced by the fan manufacturer. The fan shall have die-formed, streamlined inlets and the scroll shall be constructed of steel with all seams sealed airtight. The fan shall have steel shafts operating in self-aligning, grease lubricated ball bearings.

Units 5 tons [17.5 kW] and smaller shall have direct or belt driven fans. Where direct driven fans are used, the fan shall have multiple speeds to allow for airflow adjustment. Units greater than 5 tons [17.5 kW] shall have V-belt drive with

adjustable sheaves and shall be designed for 50 percent overload. The supply fan motor shall conform to the requirements of the Electric Motors paragraph. Vibration isolators shall be provided for the fan assembly and motor assembly.

Static pressure values indicated on the Drawings are external to the complete unit. Internal coil(s), dampers, filters and fan housing losses are not included. A filter allowance of 0.35 inch water column [0.087 kPa] shall be used for 2 inch [50 mm] pleated filter losses.

The outdoor fans shall be direct drive, vertical discharge, propeller type with aluminum blades. Fan motors shall be weatherproof with permanently lubricated ball bearings and built-in thermal overload protection. A corrosion resistant wire guard shall be installed over the fan opening.

2-5.03.08. Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Each packaged air conditioning or heat pump unit shall have a minimum number of capacity reduction steps as indicated in the schedules on the Drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2-5.03.09. Refrigerant Circuit. The factory sealed refrigerant system shall consist of compressors, outdoor coils, indoor coils, expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, refrigerant piping, and a full operating charge of refrigerant. Units with multiple stages shall have a separate refrigerant circuit for each stage where available as a manufacturer's standard option. Service gauge connections shall be furnished on the suction, discharge, and liquid lines. Units with multiple compressors shall have multiple circuits with separate expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, compressor, and refrigerant charge. All factory

installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

The refrigerant circuit shall be constructed using field provided ACR copper, de-hydrated, refrigerant rated copper pipe, piped together with manufacturer supplied Heat recovery unit(s) and Y- branches, as may be required, connected to multiple (ducted, non-ducted or mixed combination) indoor units to effectively and efficiently control the heat pump operation or simultaneous heating and cooling operation of the heat recovery VRF system. Other pipe materials, if used, shall perform, at a minimum, as well as that specified above, shall not have any adverse reactions, for example galvanic corrosion, to any other components or materials also in use in the system and shall be installed per manufacturer's instructions.

2-5.03.10. Outdoor Coil. The outdoor coil shall be of the air-cooled integral finned tube type. The coil shall be constructed of copper tubes with aluminum fins permanently and securely bonded to the tubes. The coil shall be factory leak and pressure tested. The coils shall be protected with hail guards.

2-5.03.11. Accessories. Where indicated on the Drawings, the packaged unit shall be provided with an economizer to automatically utilize up to 100 percent of outside air for cooling. The economizer shall modulate return and outside air dampers to maintain proper discharge temperature into the conditioned space. The dampers shall be equipped with automatic lockout when the outside air conditions are not suitable for proper cooling, and shall have adjustable minimum position control. The damper motor shall be spring return and shall operate to close the outside damper during shutdown. 100 percent relief of the return air shall be provided. The economizer shall be factory installed unless not available as a factory option. Where not available as factory installed, a field installed economizer shall be furnished and installed including damper, hood, controls, and all appurtenances required for a complete installation.

Where an economizer package is not specified, a manually set air damper shall be furnished to provide the indicated outside air volume.

2-5.03.12. Controls. Each packaged unit shall be completely factory wired with a single point power connection and factory installed integral disconnect switch. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect switch for field installation on the unit shall be provided. All wiring shall be installed in accordance with the National Electrical Code.

The unit shall be provided with remote control and monitoring panel consisting of system operation switches and signal lights. The signal lights shall be provided for power and dirty filters.

Packaged units shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor, outdoor fan, and indoor fan motors, and internal control power transformer.

Defrost controls, electronic timed initiated and temperature terminated with field adjustable timer shall be provided for all packaged heat pumps. When auxiliary electric heating is provided, a factory installed emergency heat package shall be provided. When heating is locked out, the auxiliary heat shall be activated as necessary.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat; terminal points to energize remote dirty filter, heating mode, cooling mode, and service indicating lights; and terminal points to de-energize the unit upon detection of smoke.

A thermostat for operation of the unit shall be furnished and installed as indicated and located where indicated on the Drawings. The thermostat shall be a programmable wall mounted type and shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45°F to 95°F [7°C to 35°C] with the following features:

- 7 day programming with 2 occupied/unoccupied periods per day.
- Automatic heat/cool changeover.
- Battery backup.
- Setback controls to automatically restart and temporarily operate system during setback periods.
- Digital display.
- Temporary override of setpoints.
- 2 configurable LED's.
- Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

2-5.04. Wall Air Conditioning Units. A wall air conditioner heat pumps denoted by the symbol "WPHP" and an identifying number shall be furnished and installed where indicated on the Drawings. which is designed to offer maximum indoor comfort at a minimal cost without using valuable indoor floor space or outside

ground space. on as indicated on the Drawings. The unit manufacturer and model number shall be Bard, Marvair or equal.

The unit shall be complete with hermetic motor-compressor, evaporator coil, condenser coil, fan motor, evaporator blower and condensing fan, drain pan, accessory wall mounted thermostat, and all other necessary operating and safety controls. Each unit shall be fully charged with R-410A and compressor oil. The unit shall be designed to operate on the power supply as indicated on the Drawings.

The accessory thermostats, humidistats and lead/lag controller for operation of the unit shall be furnished and installed as indicated and located where indicated on the Drawings. The thermostat shall be a manual changeover wall mounted type. The thermostats shall have a setpoint range of approximately 45°F to 95°F.

A remote Lead/Lag Control Panel denoted by the symbol “LLCP” and an identifying number, provided by the manufacturer of the Air Conditioning equipment, shall be furnished and installed as indicated and located on the Drawings. The lead/lag control panel shall be compatible with a programmable wall mounted type thermostat and shall be single or multistage as required by the controlled equipment. The controller shall be designed to operate a partially redundant air conditioning system and shall have a programmable function to alternate the lead and lag units on a schedule that is user adjustable. The control panel shall be compatible with thermostats having a setpoint range of approximately 45°F to 95°F and the control panel shall have following features:

- Battery backup.
- Digital display- 4 character LCD.
- Control cooling stages: 2 for each AC unit (total 4).
- Temporary override for setpoints.
- LEDs for basic controller: Lead Unit, Cooling stages 1 through 4.
- Locking feature, allows controller to be locked to prevent unauthorized changes in programming.
- Dry contact auxiliary alarms, programmed as a general alarm for all system alerts.
- Where an economizer is used, the controls shall be suitable for interfacing with the economizer control package.

The manufacturer of the equipment provided shall have a local service center.

2-5.04.01. Extra Materials.

Extra Materials	Quantity
Complete changes of lubricating oil	1

Sets of air filters 2

2-5.04.02. Performance and Design Requirements. The units shall be completely factory assembled and tested, piped, internally wired, fully charged with R-410A and compressor oil, and shipped in one piece. The unit shall be designed for direct expansion cooling and configured for heating type indicated.

The unit shall be suitable for the power supply and shall have the capacities indicated on the Drawings. Cooling capacities listed in the schedule are gross cooling capacity.
The refrigeration system shall be capable of satisfactory cooling operation at the maximum and minimum outdoor ambient air temperatures indicated on the Drawings. In addition, heat pumps shall be capable of satisfactory heating operation at the outdoor ambient temperature indicated on the Drawings. Where units need to operate in the cooling mode at a lower temperature than the factory standard as indicated in the schedules on the Drawings, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F [-18°C] consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature.

Where indicated in the schedules on the Drawings, all copper and other surfaces subject to corrosion from the atmosphere indicated shall be given a special coating.

2-5.04.03. Casing. The unit casing shall be of weatherproof design and shall be constructed of 20 gage [0.91 mm] or heavier zinc-coated steel. The casing shall be properly reinforced and braced for maximum rigidity. The casing shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard baked enamel finish. Interior surfaces of exterior casing members in contact with the airstream shall have 1 inch [25 mm] thick, 1 pound [454 kg] density, insulation coated on the air side. Aluminum foil-faced glass fiber insulation shall be used in gas fired heating sections. Hinged, insulated, neoprene gasketed access doors or removable panels shall be provided to permit easy inspection and maintenance. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1. Removable insulated access panels shall have aluminum or steel covering on the interior to protect the insulation. The unit base shall be a one-piece, welded assembly with suitable roof curb sealing gasket and curb overhang for water runoff. Drains shall be provided to accommodate outdoor coil runoff.

2-5.04.04. Indoor Coil Section. The indoor coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory leak tested underwater at 200 psig [1380 kPa gauge]. The coil shall be provided with expansion device or valve, filter-dryer, and moisture indicator. The indoor coil section shall have fully insulated, sloped drain pan extending under the entire coil section and extending sufficiently past the coil to capture

and collect any condensate carryover that may be produced when the unit is operating within the specified operating conditions. The drain pan construction shall comply with the requirements of ASHRAE 62.1.

2-5.04.05. Heating Sections. The unit shall have an electric heating coilan auxiliary electric heating coila heating section of the type scheduled on the Drawings.

Electric coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code. The heating coil shall have the minimum number of stages indicated in the schedules on the Drawings.

2-5.04.06. Filters. Filters shall be mounted integral within the packaged air conditioning or heat pump unit and shall be 2 inches [50 mm] thick. Hinged access doors shall be provided. Filters shall conform to the requirements in the Heating, Ventilating, and Air Conditioning Systems section or Air Distribution Systems section.

2-5.03.07. Fans and Motors. The indoor supply fan shall be forward-curved, multiblade, centrifugal type and shall be statically and dynamically balanced by the fan manufacturer. The fan shall have die-formed, streamlined inlets and the scroll shall be constructed of steel with all seams sealed airtight. The fan shall have steel shafts operating in self-aligning, grease lubricated ball bearings.

Units 5 tons [17.5 kW] and smaller shall have direct or belt driven fans. Where direct driven fans are used, the fan shall have multiple speeds to allow for airflow adjustment. Units greater than 5 tons [17.5 kW] shall have V-belt drive with adjustable sheaves and shall be designed for 50 percent overload. The supply fan motor shall conform to the requirements of the Electric Motors paragraph. Vibration isolators shall be provided for the fan assembly and motor assembly.

Static pressure values indicated on the Drawings are external to the complete unit. Internal coil(s), dampers, filters and fan housing losses are not included. A filter allowance of 0.35 inch water column [0.087 kPa] shall be used for 2 inch [50 mm] pleated filter losses.

The outdoor fans shall be direct drive, side discharge, propeller type with aluminum blades. Fan motors shall be weatherproof with permanently lubricated ball bearings and built-in thermal overload protection. A corrosion resistant wire guard shall be installed over the fan opening.

2-5.04.08. Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor

motor shall have temperature and current sensitive overload protection devices. Each packaged air conditioning or heat pump unit shall have a minimum number of capacity reduction steps as indicated in the schedules on the Drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2-5.04.09. Refrigerant Circuit. The factory sealed refrigerant system shall consist of compressors, outdoor coils, indoor coils, expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, refrigerant piping, and a full operating charge of refrigerant. Units with multiple stages shall have a separate refrigerant circuit for each stage where available as a manufacturer's standard option. Service gauge connections shall be furnished on the suction, discharge, and liquid lines. Units with multiple compressors shall have multiple circuits with separate expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, compressor, and refrigerant charge. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

The refrigerant circuit shall be constructed using field provided ACR copper, de-hydrated, refrigerant rated copper pipe, piped together with manufacturer supplied Heat recovery unit(s) and Y- branches, as may be required, connected to multiple (ducted, non-ducted or mixed combination) indoor units to effectively and efficiently control the heat pump operation or simultaneous heating and cooling operation of the heat recovery VRF system. Other pipe materials, if used, shall perform, at a minimum, as well as that specified above, shall not have any adverse reactions, for example galvanic corrosion, to any other components or materials also in use in the system and shall be installed per manufacturer's instructions.

2-5.04.10. Outdoor Coil. The outdoor coil shall be of the air-cooled integral finned tube type. The coil shall be constructed of copper tubes with aluminum fins permanently and securely bonded to the tubes. The coil shall be factory leak

and pressure tested. The coils shall be protected with hail guards.

2-5.04.11. Accessories. Where indicated on the Drawings, the packaged unit shall be provided with an economizer to automatically utilize up to 100 percent of outside air for cooling. The economizer shall modulate return and outside air dampers to maintain proper discharge temperature into the conditioned space. The dampers shall be equipped with automatic lockout when the outside air conditions are not suitable for proper cooling, and shall have adjustable minimum position control. The damper motor shall be spring return and shall operate to close the outside damper during shutdown. 100 percent relief of the return air shall be provided. The economizer shall be factory installed unless not available as a factory option. Where not available as factory installed, a field installed economizer shall be furnished and installed including damper, hood, controls, and all appurtenances required for a complete installation.

Where an economizer package is not specified, a manually set air damper shall be furnished to provide the indicated outside air volume.

2-5.04.12. Controls. Each packaged unit shall be completely factory wired with a single point power connection and factory installed integral disconnect switch. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect switch for field installation on the unit shall be provided. All wiring shall be installed in accordance with the National Electrical Code.

The unit shall be provided with remote control and monitoring panel consisting of system operation switches and signal lights. The signal lights shall be provided for power and dirty filters.

Packaged units shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor, outdoor fan, and indoor fan motors, and internal control power transformer.

Defrost controls, electronic timed initiated and temperature terminated with field adjustable timer shall be provided for all packaged heat pumps. When auxiliary electric heating is provided, a factory installed emergency heat package shall be provided. When heating is locked out, the auxiliary heat shall be activated as necessary.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and

the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat; terminal points to energize remote dirty filter, heating mode, cooling mode, and service indicating lights; and terminal points to de-energize the unit upon detection of smoke.

A thermostat for operation of the unit shall be furnished and installed as indicated and located where indicated on the Drawings. The thermostat shall be a programmable wall mounted type and shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45°F to 95°F [7°C to 35°C] with the following features:

- 7 day programming with 2 occupied/unoccupied periods per day.
- Automatic heat/cool changeover.
- Battery backup.
- Setback controls to automatically restart and temporarily operate system during setback periods.
- Digital display.
- Temporary override of setpoints.
- 2 configurable LED's.
- Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

2-5.05. Ductless Split Systems. Not used.

2-5.06. Water Chillers. Not used.

2-5.07. Multi-Split Variable Refrigerant Flow (VRF) Systems. Multi-split systems denoted by the symbol "HP" and an identifying number shall be furnished and installed where indicated on the Drawings. The system shall be variable refrigerant flow type, designed for heat recovery, and include multiple indoor ceiling suspended fan coil sections and outdoor remote heat pumps. Each unit or system shall be fully charged with R-410A and compressor oil. A programmable thermostat/controller shall be provided for control of each fan coil section. All components of the system shall be provided by a single equipment supplier to ensure proper system operation.

Heat recovery models shall be able to heat and cool separate thermal zones simultaneously.

Multi-split Ductless variable refrigerant flow split systems shall be as manufactured by LG, Daikin, Mitsubishi.

The manufacturer of the equipment provided shall have a local service center. Unit shall be air cooled, split type multi-system heat pump consisting of one outdoor unit and multiple indoor units, each having capability to cool or heat independently for the requirements of the rooms. Indoor units shall be connected to one refrigerant circuit and controlled individually, or for the Control Room where two units shall be controlled by one thermostat.

Compressor shall be equipped with inverter controller, and capable of changing the rotating speed to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix-match connection of following models:

Ceiling Mounted Cassette 4 Way Type
Ducted – High Static Type
Wall Mounted High Efficiency Unit

The refrigerant piping shall be extended up to 540 feet with a 131-foot elevation difference without any oil traps. Heat pump shall be capable of operating continuously at the ambient temperature of 23°F in cooling and 0°F in heating. Both indoor units and outdoor unit shall be assembled, tested, and charged with refrigerant at the factory.

2-5.07.01. Fan Coil Units. Each fan coil unit, denoted by the symbol "FCU" and an identifying number, shall be of the ductless, indoor, in-ceiling cassette mounted, suspended cassette, Wall mounted or concealed ducted direct expansion type as indicated on the Drawings. Each fan coil unit shall consist of a fan, coil, mounting harness, condensate pump, and drain pan. Each cassette fan coil unit shall also have an air filter, return grille, and supply louvers. The fan coil units shall be LG, Daikin and Mitsubishi.

Fans shall be centrifugal type designed for quiet operation. Coils shall be copper tube with aluminum fins and galvanized steel tube sheets. The fins shall be bonded to the tubes by mechanical expansion. Air filters shall be of the cleanable type. Each unit shall be provided with access doors for easy removal of the filters. Each fan coil shall be provided with a mounting system and supports.

The fan coil fan shall be suitable for the power supply indicated on the Drawings. The fan coil shall have an electronic control valve which controls refrigerant flow rate in respond to load variations of the room.

2-5.07.02. Heat Recovery Unit Boxes. Each Heat Recovery Unit Box denoted by the symbol "HRU" and an identifying number. Shall require three pipes between the outdoor unit and the heat recovery unit and two pipes between the heat recovery unit and each indoor unit to support simultaneous heating and cooling. Between the outdoor unit and heat recovery unit, one pipe shall support bidirectional flow single state liquid refrigerant. The second pipe shall deliver flow

of low pressure, low temperature refrigerant gas from the heat recovery unit to outdoor unit. The third pipe shall deliver single state, super-heated, refrigerant hot gas during simultaneous and 100% heating operations from the outdoor unit to heat recovery unit. Heat Recovery systems using two pipes that deliver mixed state (hot gas and liquid) with separation occurring in heat recovery unit shall not be accepted.

2-5.07.03. Controls. Computerized PID control shall be used to maintain a correct room temperature. The system shall be equipped with self-diagnosis for easy and quick maintenance and service. The microprocessor controller remote controller shall memorize the latest malfunction code for easy maintenance.

A multi-functional centralized controller (central remote controller) shall be supplied as an accessory and located as shown on the drawings. It shall be able to control up to 128 indoor units with the following functions:

a) Temperature setting for each zone, or group, or indoor unit.
b) On/off as a zone or individual unit.
c) Indication of operating condition.
d) Select one of 10 operation modes for each zone.

A schedule timer shall be supplied as optional accessory. It shall be able to set operation schedule of up to 128 indoor units. The operation schedule shall include twice on/off a day and holiday. It shall be able to set 8 patterns of schedule combined with centralized controller.
The system shall allow individual cooling or heating by each indoor unit simultaneously, or of all the indoor units associated with each branch selector box.

2-5.07.04. Accessories. Each fan coil unit shall be provided with an electric programmable thermostat capable of interfacing with the system control An internal condensate pump shall be provided to remove condensate from the fan coil drain pan.

All copper surfaces shall be protected against corrosion by a shop applied special coating."

2-6. ELECTRICAL. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2-7. DRIVE UNITS. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2-8. MANUFACTURE AND FABRICATION. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2-9. SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2-10. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3-1. INSPECTION. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3-2. PREPARATION.

3-2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3-2.02. Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of

previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath the baseplate shall be grouted as specified in the Grouting section.

3-3.01. Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the valve sections.

3-3.02. Refrigerant Piping and Accessories. The refrigerant piping shall be sized and arranged in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and transmission of sound to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform return of oil to the compressor. The suction gas line shall be sized to produce a minimum load gas velocity of 1,000 feet per minute [5 m/sec] in vertical risers with upward gas flow and 500 feet per minute [2.5 m/s] in horizontal piping. The full load pressure drop should not exceed 3 psi [20 kPa] or 2°F [1°C] change in saturated refrigerant temperature. The maximum gas velocity shall not exceed 4,000 feet per minute [20 m/s]. The liquid lines shall be sized to limit the pressure loss to the equivalent of 2°F [1°C] of temperature change and a maximum liquid line velocity of 360 feet per minute [1.8 m/s]. A piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction shall be submitted in accordance with the Submittals section.

3-3.03. Heat Pumps. The condensing units and heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the Drawings.

After the refrigerant system has been tested, the system shall be fully charged with refrigerant and compressor oil.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-3.04. Packaged Heat Pumps. The packaged air conditioning units and packaged heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored to the equipment curbs with corrosion resistant fasteners.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-3.05. Ductless Split Systems. Ductless split systems shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the recommended clearances.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-3.06. Multi-Split Variable Refrigerant Flow Systems. Multi-split VRF systems shall be installed in accordance with the manufacturer's installation instructions. All units in the system shall be levelled and installed to maintain the recommended clearances.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph."

3-3.07. Wall Air Conditioning Units. The wall air conditioning units shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored to the equipment curbs with corrosion resistant fasteners.

The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3-4. FIELD QUALITY CONTROL.

3-4.01. Installation Check. An installation check by an authorized representative of the manufacturer is not required for equipment specified in this section.Where an installation check by the manufacturer is specified in the equipment installation paragraphs above, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-4.02. Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable

3-4.03. Operator Instruction and Training. Not used.After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

a. Documentation in the final Operation and Maintenance Manuals.
b. Use the Operation and Maintenance Manuals.
c. Equipment and system startup and shutdown.
d. System operation procedures for all modes of operation.
e. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as required.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3-5. CLEANING. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings,

and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

Section 26 05 11

ELECTRICAL

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.

This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

1-2. GENERAL. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Coordination. Electrical work shall conform to the construction schedule and the progress of other trades.

1-2.04. Anchor Bolts and Expansion Anchors. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch 19 mm will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

1-2.05. Drawings. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1-3. CODES AND PERMITS. All work shall be performed and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

AEIC	The Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Fed Spec	Federal Specification
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories
CEC	California Electrical Code

Equipment covered by this section shall be listed by UL,.

1-4. SEISMIC DESIGN REQUIREMENT.

1-4.01. Seismic Design Requirements. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-5. IDENTIFICATION.

1-5.01. Conduit. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags.

1-5.02. Conductors. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.

1-5.02.01. Conductor Identification Number. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at the point of termination.

The wire numbers shall be as indicated on the equipment manufacturer's drawings.

The wire markers shall be positioned to be readily visible for inspection.

1-5.02.02. Conductor Color Coding. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.

The following color coding system shall be used:

120/240V single-phase — black, red, and white
120/208V, three-phase — black, red, blue, and white
120/240V, three-phase — black, orange, blue, and white
277/480V, three-phase — brown, orange, yellow, and gray

Where 120/240 and 120/208 volt systems share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.

1-5.03. Motor Starters. Motor starters shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.). Nameplates shall be laminated black-over-white plastic, with 1/8 inch 3 mm engraved letters, and shall be securely fastened to the motor starters.

1-5.04. Control Stations.Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.). Nameplates shall be laminated black-over-white plastic, with 1/8 inch 3 mm engraved letters, and shall be securely fastened to the control stations.

1-5.05. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated black-over-white plastic, with 1/8 inch 3 mm engraved letters, and shall be securely fastened to the circuit breakers.

1-5.06. Disconnect Switches. All switches shall have front cover-mounted permanent nameplates that include switch type, manufacturer's name and catalog number, and horsepower kW rating. An additional nameplate, engraved or etched, laminated black-over-white plastic, with 1/8 inch 3 mm letters, shall be provided to identify the associated equipment. Both nameplates shall be securely fastened to the enclosure.

1-5.07. Arc Flash Hazard Labels. Lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter socket enclosures, local panels with local starters/drive, and other electrical equipment likely to be worked on energized shall be provided with

permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E.
Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

Additional information shall be provided on the labels where specified in the Arc Flash Hazard Analysis section of this section.

1-6. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Design-Builder, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Drawings and data.
Operating manuals.
Samples.
Test reports
Studies

1-6.01. Submittal Identification. Information covering all materials and equipment shall be submitted for review in accordance with the Submittal Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.

b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.

c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.

d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.

e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

f. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.

1-6.02. Seismic Design Requirements. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-7. PROTECTION AND STORAGE. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2-1. POWER SERVICE ENTRANCE. . Electrical Subcontractor shall consult the local electric utility regarding their service installation requirements, and shall furnish the service equipment in compliance with these requirements.

Power service equipment to be furnished by Electrical Subcontractor shall include, but is not limited to, meter board, meter socket, meter test cabinet, meter transformer cabinet, disconnecting means ,grounding materials, riser conduits, and other service entrance fittings required by the utility and for compliance with local codes and regulations.

Electrical Subcontractor shall also provide conduits, transformer pads, and other underground service entrance fittings required by the utility for underground service installation. Trenching and backfill of the duct banks will be by others.

2-2. TELEPHONE SERVICE ENTRANCE. Electrical Subcontractor shall consult the local telephone utility regarding their service installation requirements.

Electrical Subcontractor shall install telephone lines for the Operations Building office connection and for the main fire alarm control panel located in the Operations Building.

2-3. CABLE. All cables of each type (such as lighting cable or 600 volt power cable) shall be from the same manufacturer.

All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.

2-3.01. Lighting Cable. Lighting cable (Figure 1-26 05 11THHN-THWN) shall be provided only in lighting and receptacle circuits operating at 277 volts or less. Lighting and receptacle circuits, 8 AWG 10 mm2 or larger, shall be as specified for 600 volt (Figure 2-26 05 11XHHW-2)(Figure 3-26 05 11THHN-THWN) power cable.

2-3.02. 600 Volt Power Cable. Cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are required, shall be 600 volt (Figure 2-26 05 11 XHHW-2)(Figure 3-26 05 11 THHN-THWN) power cable.

2-3.03. Instrument Cable. Cable for electronic circuits to instrumentation, metering, and other signalling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be (Figure 4-26 05 11 single pair), (Figure 5-26 05 11 single triad), or (Figure 6-26 05 11 multiple pair and/or triad).

2.3.04. Multiconductor Control Cable. Cable shall be (Figure 7-26 05 11 14 AWG THHN-THWN) or (Figure 8-26 05 11 12 AWG THHN-THWN).

2-3.05. Medium Voltage Power Cable. Not used.

2-3.06. Tray Cable. Not used.

2-3.07. Metal Clad Lighting Cable. Metal clad lighting cable (Figure 14-26 05 11 16050 Metal Clad THHN) shall be provided only in lighting and receptacle circuits operating at 277 volts or less, concealed in interior partition walls and above suspended ceilings of finished office and administration areas.

2-4. RACEWAY. Conduit and cable tray shall be as described in the following paragraphs:

2-4.01. Rigid Steel Conduit. Rigid steel conduit shall be heavy wall, hot-dip galvanized, shall conform to NEMA C80.1, and shall be manufactured in accordance with UL 6.

2-4.02. Intermediate Metal Conduit (IMC). IMC shall be hot-dip galvanized, shall conform to NEMA C80.6, and shall be manufactured in accordance with UL 1242.

2-4.03. Liquidtight Flexible Metal Conduit. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moistureproof polyvinyl chloride jacket, and shall be UL labeled.

2-4.04. Utility Duct. Conduit shall be in accordance to PG&E's requirements.

2-4.05. Rigid Nonmetallic (PVC) Conduit. PVC conduit shall be heavy wall, Schedule 40 and 80, UL labelled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL 651.

2-4.06. PVC-Coated Rigid Steel Conduit. The conduit shall be rigid steel. Before the PVC coating is applied, the hot-dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating.

Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches 50 mm, whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating.

All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.

2-4.07. Electrical Metallic Tubing (EMT). EMT shall be hot-dip galvanized, shall conform to NEMA C80.3, and shall be manufactured in accordance with UL 797.

2-4.08. Rigid Aluminum Conduit (RAC). Not used.

2-4.09. Cable Tray. Not used.

2-5. WIRING DEVICES, BOXES, AND FITTINGS. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

2-6. JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS. Indoor boxes (larger than switch, receptacle, or fixture type) and gutters shall be constructed of sheet steel, shall be galvanized after fabrication, and shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

Indoor boxes and gutters in corrosive areas and outdoor boxes and gutters shall be NEMA Type 4X, ABS or stainless steel and shall be rigidly supported by PVC-coated or stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

Bolt-on junction box covers 3 feet 900 mm square or larger, or heavier than 25 lbs 11 kg, shall have rigid handles. Covers larger than 3 by 4 feet 900 by 1200 mm shall be split.

Junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2-7. LIGHTING FIXTURES. Lighting fixtures shall be furnished. Lighting fixtures shall be furnished complete with lamps. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise specified. Lighting fixtures shall be provided with disconnects in accordance with NEC requirements.

2-7.01. Electronic Drivers. Electronic drivers furnished with LED type lighting fixtures shall be certified as meeting requirements of ANSI C82.77 with a THD level of not more than 20 percent.

2-8. LIGHTING PANELS. Each lighting panel shall be a dead-front, 120/240 volt, single phase or 120/208 volt, three phase panelboard with circuit breakers, in accordance with the following:

2-8.01. Cabinet. The wall-mounted enclosure shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a hinged trim (cover). Breaker operating handles shall be accessible through a latched, lockable, door. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

2-8.02. Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip. Breakers shall have interrupting ratings not less than 10,000 amperes. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed. Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings

Circuit breakers shall include arc-fault circuit interrupter (AFCI) and/or ground fault circuit interrupter (GFCI) protection functions. Where GFCI breakers dedicated to protect heat tracing circuits, GFCI breakers shall be configured for equipment protection with a ground fault trip threshold of 30 mA. Otherwise, GFCI breakers shall be configured for personnel protection with a ground fault trip threshold of 5 mA.

2-8.03. Buses. The panel shall have main and neutral buses insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2-8.04. Interior Lighting. Free-standing enclosure with electrical equipment inside shall have ceiling mounted lamp fixtures with a door activated switch and on/off switch.

2-8.05. Air-Conditioned Equipment. Outdoor free-standing enclosure with electrical equipment inside shall have temperature regulated air conditioning equipment to maintain the enclosure temperature within the allowable operating temperature range for the electrical equipment. It shall have temperature regulated anti-condensation heater.

2-8.06. Transformer. A single 480Vac power feed will be provided for 480Vac rated enclosure. The enclosure shall be provided with step-down transformer(s) if other voltage levels other than 480Vac is needed.

2-9. POWER PANELS. Unless otherwise specified, each power panel, without a neutral, shall be dead-front, 3 phase panelboard with circuit breakers, in accordance with the Drawings and the following:

2-9.01. Cabinet. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a door with latch and lock. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

2-9.02. Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip type. Breakers up to 240 volts shall have interrupting ratings not less than65,000 amperes. Breakers for 277 volts shall have interrupting ratings not less than 65,000 amperes. Breakers for 480 volts shall be rated 600 volts, with interrupting ratings not less than 65,000 amperes at 480 volts. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed.

2-9.03. Buses. The panel shall have 3 phase buses and a ground bus. Buses shall be copper, with ampere and voltage ratings and main lugs or breakers as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp

type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2-10. SURGE PROTECTIVE DEVICES.

2 -10.01. Scope. Surge protective devices (SPD) shall be provided as specified herein. Each unit shall be designed for parallel connection to the wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.

Each SPD shall be furnished and installed for the electrical equipment as specified herein. All new lighting and power panels shall be furnished with an integral SPD.

Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

Power panels shall have SPD's rated for a medium-highexposure levels.

2-10.02. Standards. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41 and C62.45;

ANSI/IEEE C62.1 and C62.11;

IEEE C62.62;

National Electrical Manufacturers Association (NEMA LS1 Guidelines);

National Fire Protection Association (NFPA 20, 70 NEC, 75, and 780);

Underwriters Laboratories UL 1449 and 1283

The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

2-10.03. Environmental Requirements.

a. Operating Temperature: 0°F to +140°F -18°C to +60°C.

b. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

2-10.04. Electrical Requirements.

a. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.

b. Maximum Continuous Operating Voltage (MCOV). The SPD shall be

designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.

c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.

d. Protection Modes. Four-wire configured systems shall provide, Line-to-Neutral (L-N), Line-to-Ground (L-G), and Neutral-to-Ground (N-G), and Line-to-Line (L-L) protection. Three-wire configured systems shall provide, Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.

e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and shall be no less than listed in the following table.

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

f. UL 1449 Voltage Protection Rating (VPR). The maximum VPR per mode for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
120/240 1-phase	800 V	800 V	800 V	1200 V
120/208 3-phase	800 V	800 V	800 V	1200 V
240 V 3W		800 V		1500 V
240 V 4W	800 V	800 V	800 V	1500 V
480 V 3W		1200 V		2000 V
480 V 4W	1200 V	1200 V	1200 V	2000 V

g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.

h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.

i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200 kA symmetrical fault current with 600 volts ac applied.

At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.

The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit. When furnished integral to the panelboard, the status indicators shall be viewable when the panelboard door is opened.

2-10.05. Installation. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

2-10.06. Miscellaneous.

a. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL 1449 listed as such, and the UL 1449 Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.

b. Enclosure. For the SPD units to be mounted externally of the protected electrical equipment, provide NEMA rated enclosures suitable for the locations.

c. Dual Form "C" Dry Contacts.

2-11. SEPARATELY ENCLOSED MOTOR STARTERS. Separately enclosed motor starters, unless otherwise specified, shall be full voltage, magnetic, non-reversing and NEMA rated. The starter enclosures shall have NEMA type designations appropriate for the locations where they will be installed. Unless otherwise noted, NEMA Type 4X stainless steel enclosures shall be provided for outdoor locations.

Heaterless overload protection shall be provided by three current sensors monitored by a microprocessor. The overload device shall also include phase loss and unbalance protection, trip class selection, Class II ground fault protection, and manual reset

Each starter shall include auxiliary contacts as required, plus one spare NO and one spare NC contact.

Supplier shall match the sizes of control power transformers, overload devices, heaters, and starters to the equipment furnished. Control power transformers

shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

All starters shall be provided with control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.

All push buttons, selector switches, and pilot lights to be provided on or in the starter enclosure shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps. Push buttons on starters located outdoors shall be provided with protective caps.

2-11.01. Three Phase Starters. Three phase starters shall be circuit breaker combination type consisting of 3 phase, 60 Hz contactors with heaterless overloads, a 120 volt ac coil, a dry type control power transformer where required, and a circuit breaker disconnect. Control power transformers shall be sized to handle all simultaneous loads.

Circuit breakers shall be 600 volt magnetic motor circuit protectors for motors smaller than 100 horsepower 75 kW and 600 volt thermal-magnetic type for 100 horsepower 75 kW and larger motors. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism.

Three phase starters shall be furnished with external manual breaker operating handles and provisions for up to three padlocks. The access door shall be interlocked with the motor circuit protector, so that the door cannot be opened, except by an interlock override, while the breaker is closed.

The complete 3 phase starter shall have an interrupting rating of at least 25,000 amperes at 480 volts.

2-11.02. Single Phase Starters. Single phase starters shall consist of single phase, 60 Hz contactors with thermal overloads and an integral or separately enclosed short-circuit protection device. Starters shall be at least NEMA Size 0. Integral short-circuit protection devices for single-phase starters shall be 120/240 volt, magnetic motor circuit protectors.

Separately enclosed short-circuit protection devices for single phase starters shall be molded-case circuit breakers for motor loads 6 amperes and higher and fused switch disconnects for motor loads lower than 6 amperes. Circuit breaker disconnects shall be 120/240 volt, molded-case, thermal-magnetic circuit breakers. Fused switch disconnects shall have quick-make, quick-break mechanisms and 250 volt, dual-element, time-delay fuses.

The short-circuit protection devices shall have external operating handles capable of being padlocked in the open position, and shall have an interrupting rating of at least22,000 amperes at 240 volts.

Outdoor enclosure housing any electrical equipment like variable frequency drive, motor starter, or control equipment shall be free-standing with legs rated for NEMA 4 or with a NEMA designation appropriate for the location where it will be installed. It shall be air-conditioned to maintain the enclosure temperature for the electrical equipment and/or electronic device to operate within its allowable operating temperature range. The enclosure shall have local disconnect switch with operating handle accessible through a latched, lockable, door. Separate enclosure shall be provided for 480Vac equipment and 120Vac equipment. The enclosure shall have corrosion protection in the outdoor environment. All external conduit entry shall be at the bottom.

Indoor enclosure shall be free-standing with legs rated for NEMA 4 or with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have local disconnect switch with operating handle accessible through a latched, lockable, door. Separate enclosure shall be provided for 480Vac equipment and 120Vac equipment. The enclosure shall have corrosion protection appropriate for the location where it will be installed. All conduit entry shall be at the bottom as much as possible.

2-12. SEPARATELY ENCLOSED MANUAL STARTERS. Not used.

2-13. CONTROL STATIONS. Control stations shall be provided as indicated on the one-line diagrams or schematics or as required by the equipment furnished. Pilot devices shall be 30.5 mm heavy-duty, oiltight construction, and shall perform the functions indicated. Pilot lights shall be full voltage type with LED lamps. Indoor control stations shall have NEMA Type 13 enclosures. Control stations outdoors or indicated to be weatherproof shall have NEMA Type 4X stainless steel enclosures with protective caps on the control devices. Control stations in NEC Class I, Division 1 and Division 2, Group D hazardous areas shall have NEMA Type 7 enclosures, or be factory sealed type.

2-13.01. Emergency Break-Glass Switch. Not used.

2-14. SEPARATELY ENCLOSED CIRCUIT BREAKERS. Circuit breakers shall be 3 pole, 480 volt, molded-case circuit breakers of not less than65,000 amperes interrupting rating at 480 volts ac, complete with thermal and instantaneous trip elements. Breaker enclosures shall have NEMA designations appropriate for the locations where they will be installed. NEMA Type 4X stainless steel enclosures shall be provided for outdoor locations. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal

elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration.

Circuit breakers shall have "On", "Off", and "Tripped" indication and padlockable exterior handles.

2-15. DISCONNECT SWITCHES. Unless otherwise specified, each disconnect switch shall be 3 pole, nonfusible, 600 volts, with a continuous current rating as indicated on the Drawings.

Where indicated on the Drawings, fused switches shall be furnished complete with fuses. Fuse sizing shall be as indicated on the Drawings, as required by the results of the protective device study, or as recommended by the respective protected equipment manufacturer.

Switches located indoors shall have NEMA type enclosure designations as required by the locations where they will be installed. Switches located outdoors shall have NEMA Type 4X enclosures. Switches in chlorine rooms, or in other areas where contact with caustic substances may occur, shall have NEMA Type 4X enclosures of molded reinforced polyester.

Switches shall have high conductivity copper, visible blades; nonteasible, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base. Each switch shall have a handle whose position is easily recognizable and which can be locked in the "Off" position with three padlocks. The "On" and "Off" positions shall be clearly marked.

All switches shall be UL listed and horsepower kilowatt rated, and shall meet the latest edition of NEMA KS1. Switches shall have defeatable door interlocks that prevent the door from being opened while the operating handle is in the "On" position.

2-16. LIGHTING AND AUXILIARY POWER TRANSFORMERS. . Separately mounted transformers shall be provided in the phases, kVA, and voltages indicated on the Drawings. Transformers shall be self-air-cooled, dry type, wall- or floor-mounted, and enclosed for wiring in conduit. Transformers installed outdoors shall be weatherproof. Transformers shall have at least four full capacity voltage taps, two above and two below rated voltage. Transformers shall meet DOE 10 CFR 431 guidelines for energy efficiency.

2-17. POWER CENTERS. Not used.

2-18. AUTOMATIC POWER FACTOR CORRECTION CAPACITOR UNIT. Automatic power factor capacity (APFC) unit shall be rated 3 phase delta and for the voltage of the system to which they will be connected. The APFC unit shall

include harmonic distortion abatement equipment in compliance with IEEE 519 to protect the APFC unit from the harmonics generated by other frequency drives shown on the Drawings. Enclosures shall be suitable for the areas in which they are installed and as indicated by the area designations on the Drawings.

The kVAR sizes indicated on the Drawings are only approximate and shall be as recommended by the equipment manufacturer to improve the overall electrical system power factor to 95 percent at full load. Capacitors shall be complete with discharge resistors and fuses.

2-19. LIGHTING CONTACTORS. 2-19 is only applicable to the Electrical Subcontractor. Remote control lighting contactors shall be provided. Contactors shall have positive locking features and shall be mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 20 amperes, 600 volts ac, for all types of loads. Terminals shall accept 18 through 10 AWG conductors. Contactors shall operate in any position and may be manually operated for testing and maintenance. Contactor control panels shall be UL 508A listed. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

2-20. PHOTOELECTRIC CONTROLS. 2-20 is only applicable to the Electrical Subcontractor. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c 11 lux turn-on to 15 ft/c 161 lux turn-off.

2-21. RELAY ENCLOSURES. 2-21 is only applicable to the Electrical Subcontractor. Relay enclosures shall be furnished. The enclosure shall have a NEMA designation appropriate for the location where it will be installed. Pilot devices shall be heavy duty, oiltight construction. Relays and timers shall have 120 volt, 60 Hz coils rated for continuous duty in 40 C ambient and 10 ampere, 120 volt ac contacts. Intrinsically safe relays shall be installed within the enclosures in accordance with NEC requirements.

2-22. ALARM HORN AND BEACON. Not used.

2-23. HEAT-TRACED PIPING. Outdoor exposed piping shall be heat-traced described herein. Heat tracing shall be sized to maintain pipe temperatures at 40°F with an outdoor ambient temperature of -20°F. Heat tracing shall be of the self-regulating type and shall be suitable for single-phase, 120 volt service. Each run of heat tracing tape shall be provided with a circuit controller, an end-of-line indicating light, junction boxes, mounting accessories, insulation and all other equipment for a complete, properly operating system. Hazardous areas, as indicated on the Drawings and Specifications, shall have heat tracing and associated accessories that are rated for the location. The insulation for all heat

tracing shall be as specified in Mechanical Insulation section. Each heat-tracing circuit shall be provided with a microprocessor-based circuit controller to monitor temperature and ground fault current. . On all plastic pipe equipped with heat tracing, a layer of conducting tape shall be installed on the pipe before heating cable installation and then again following installation of the heating cable.

2-24. DOOR ENTRY SWITCHES. 2-24 is only applicable to the Electrical Subcontractor. Door entry switches shall be provided as specified herein. Switches shall be heavy-duty industrial, adjustable, magnetic wide gap type. Switch and magnet housings located in NEC Class I, Division 1 and 2, Group D hazardous areas shall be die-cast aluminum, explosionproof. Switch and magnet housings located in other areas shall be anodized aluminum.

PART 3 - EXECUTION

3-1. INSTALLATION, TESTING, AND COMMISSIONING. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

3-2. ARC FLASH HAZARD ANALYSIS. Electrical Subcontractor shall commission an Arc Flash Hazard Analysis for each piece of electrical equipment including lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, variable frequency drives, fused switches, local panel with local starters/drives, and other electrical equipment likely to be worked on energized, in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584.

Equipment below 240 volts need not be considered unless it involves at least one 125KVA or larger transformer in its immediate power supply.

The Arc Flash Hazard Analysis shall be performed in association with, or as a continuation of, the short circuit study and protective device study.

3-2.01. Arc Flash Labeling. Electrical Subcontractor shall furnish and install arc flash labels on the applicable electrical equipment. The arc flash labels shall comply with ANSI Z535.4 and NFPA 70E requirements. Labels shall include, at a minimum, the nominal system voltage, the arc flash boundary distance, worst-case incident energy and the corresponding working distance, date of the analysis, and equipment name.
Equipment with arc reduction maintenance mode switches shall include a dual label with the worst-case calculated incident energy level with and without the switch enabled. The label shall clearly identify the associated maintenance mode switch that shall be enabled in order for the lower incident energy level to apply.

3-3. PROTECTIVE DEVICE STUDY. Electrical Subcontractor shall commission a short circuit study and protective device study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination and protective device settings report as specified herein. The study shall be in compliance with IEEE 242 and include the entire distribution system, including any and all existing power distribution components which will impact the results of the protective device study, starting with the smallest – 480 volt, 3 phase, 60 Hz – circuit protective device on the load end, to the nearest protective device on the power company's line side.

Electrical Subcontractor shall be responsible for and shall ensure that all relays, protective devices and circuit breakers shown on the Drawings and Specifications are sized and set according to the study results.

3-4. POWER AND SERVICE ENTRANCE INSTALLATION. Electrical Subcontractor shall consult the local electric utility regarding their service installation requirements, and shall install the service equipment in compliance with these requirements. Electrical Subcontractor shall install all power service equipment components except for components installed by the utility as directed in the utility service installation requirements.

Electrical Subcontractor shall coordinate details and timing of service entrance installations with the utility. Electrical Subcontractor shall complete and submit service applications to the electric utility as necessary.

3-5. TELECOMMUNICATIONS SERVICE ENTRANCE INSTALLATION. Electrical Subcontractor shall consult the local telephone utility regarding their service installation requirements, and shall install the service equipment in compliance with these requirements.

Electrical Subcontractor shall coordinate details and timing of service entrance installations with the utility. Electrical Subcontractor shall assist the Owner to complete and submit service applications to the telephone utility as necessary.

3-6. CABLE INSTALLATION.

3-6.01. General. Except as otherwise specified cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits shall be installed continuous and may not be spliced unless approved by the Design-Builder.

a. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.

b. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may only be used for splicing solid cable and for terminations at lighting fixtures.

c. Splices may be made only at readily accessible locations.

d. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.

e. Not used.

f. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.

g. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone.

h. Not used.

i. Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by woven grips.

j. Spare cable ends shall be taped, coiled, and identified.

k. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.

l. All cables in one conduit, over 1 foot 305 mm long, or with any bends, shall be pulled in or out simultaneously.

m. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size.

n. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.

o. Not used.

3-6.02. Underground Cable Pulling Procedure. Care shall be taken to prevent excessive physical stresses that would cause mechanical damage to cables during pulling.

3-6.03. Medium-Voltage Cable Insulation Test. Not used.

3-7. RACEWAY INSTALLATION. Electrical Subcontractor shall be responsible for routing all raceway. This shall include all conduits indicated on the one-lines, riser diagrams, conduit schedules, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.

Except as otherwise specified, conduit installation and identification shall be completed according to the following procedures.

3-7.01. Installation of Interior and Exposed Exterior Conduit. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified. No conduit shall be exposed in water chambers.

Unless otherwise indicated on the Drawings, Design-Builder shall be responsible for routing the conduit to meet the following installation requirements:

a. Conduit installed in all exposed indoor locations, except corrosive areas, and in floor slabs, walls, and ceilings of hazardous (classified) locations, shall be rigid steel to 8’ above finished floor (AFF). Exposed conduit shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

   Above 8’ AFF, the conduits shall be PVC, EMT, GRS depended on the supports of the conduits.

b. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 40 PVC.

c. Conduit installed in all exposed outdoor locations shall be PVC-coated rigid steel, or GRS depended on the compatibility of the chemicals rigidly supported by PVC-coated framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

d. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquidtight flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet.

e. Terminations and connections of rigid steel and intermediate metal conduit shall be taper threaded. Conduits shall be reamed

free of burrs and shall be terminated with conduit bushings.

f. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

g. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.

h. Conduits shall be at least 6 inches 150 mm from high temperature piping, ducts, and flues.

i. Conduit installed in corrosive chemical feed and storage areas as indicated by Area Type shall be rigid Schedule 80 PVC, or GRS depended on the compatibility of the chemicals. Exposed conduit in corrosive areas shall be supported by FRP framing materials with stainless steel hardware, including nuts and bolts.

j. Rigid Schedule 40 and 80 PVC conduit shall have supports and provisions for expansion as required by NEC Article 352.

k. Metallic conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.

l. Rigid Schedule 40 and 80 PVC conduit shall be secured to sheet metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.

m. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.

n. Conduits that cross structural joints where structural movement is allowed shall be fitted with concretetight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 40 or 80 PVC conduits. .

o. Conduit shall be clear of structural openings and indicated future openings.

p. Conduits through roofs or metal walls shall be flashed and sealed watertight.

q. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of fire rated structure elements shall be sealed in a manner that maintains the fire rating.

r. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

s. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.

t. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.

u. Future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

v. Horizontal conduit shall be installed to allow at least 7 feet 2.1 m of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.

w. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Design-Builder.

x. PVC-coated rigid steel conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.

y. All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.

z. Conduit which turns out of concrete slabs or walls, shall be connected to a 90 degree elbow of PVC-coated rigid steel conduit before it emerges. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.

   Conduit which turns out of concrete slabs and into floor/slab mounted equipment, shall be schedule 40 PVC and terminated with a bell end.

aa. Conduit for Heliax type foam dielectric coaxial cable shall be installed as follows:

Heliax Size inches	mm	Minimum Conduit Size inches	mm	Minimum Conduit Bend Radius inches	mm
1/2	13	1-1/2	40	10	250
7/8	22	2	50	18	450
1-1/4	32	4	100	22	550
1-5/8	42	4	100	28	700

ab. Power conductors to and from between adjustable frequency drives and motors shall be VFD rated cable.

ac. EMT for interior/dry walls and ceilings in buildings.

3-7.02. Underground Conduit Installation. All excavation, backfilling, and concrete work shall conform to the respective sections of these Specifications. Underground conduit shall conform to the following requirements:

a. Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations shall be reinforced.

b. Concrete encased conduit shall be schedule 40 PVC. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from walls and the coupling shall extend 2 inches from the wall. All PVC joints shall be solvent welded in accordance with the recommendations of the manufacturer.

c. Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches 150 mm above grade, with top crowned and edges chamfered.

d. Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug.

e. Underground conduits indicated not to be concrete encased shall be rigid Schedule 40 PVC.

f. Underground conduit bend radius shall be at least 2 feet at vertical risers and at least 3 feet elsewhere.

g. Underground conduits and conduit banks shall have at least 2 feet of earth cover, except where indicated otherwise.

h. Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in the Cast-In-Place Concrete section.

i. Underground nonmetallic conduits, which turn out of concrete or earth in outdoor locations, shall be connected to 90 degree elbows of PVC-coated rigid steel conduit before they emerge.

j. Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

k. Underground conduits shall be sloped to drain from buildings to manholes.

l. Not used.

m. Telephone cables shall not be installed in raceways, conduits, boxes, manholes, or handholes containing other types of circuits.

n. Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.

3-7.03. Sealing of Conduits. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch and larger conduit connections to equipment.

Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.

3-7.04. Reuse of Existing Conduits. Not used.

3-8. WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION. Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

3-8.01. Conduit Boxes and Fittings.

a. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.

b. Galvanized or cadmium plated sheet steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.

c. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

d. PVC coated boxes and fittings shall be installed in PVC coated conduit systems.

e. Telephone conduit shall be provided with separate junction boxes and pull fittings.

3-8.02. Device Plates. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

3-8.03. Wall Switches.

a. Wall switches shall be mounted 3'-6" above floor or grade.

b. After circuits are energized, all wall switches shall be tested for

proper operation.

3-8.04. Receptacles.

a. Convenience outlets shall be 18 inches above the floor unless otherwise required.

b. Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.

c. Welding receptacles shall be surface-mounted 4 feet above the floor.

d. After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.

e. Conduit and wire for convenience outlet installation is not shown on the Drawings and shall be sized, furnished, and installed by Electrical Subcontractor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for convenience outlet installation.

3-8.05. Special Outlets. Not used.

3-9. EQUIPMENT INSTALLATION. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.

3-9.01. Setting of Equipment. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch thick corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.

3-9.02. Sealing of Equipment. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant.

3-10. GROUNDING.

3-10.01. General. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:

a. All ground conductors shall be at least 12 AWG 4 mm^2 soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.

b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837.

c. Ground cable through exterior building walls shall enter within 3 feet below finished grade and shall be provided with a water stop.

d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches . The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches below grade, or below the frost line, whichever is deeper.

e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.

f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.

g. The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches.

i. Ground rods not described elsewhere shall be a minimum of 3/4 inch in diameter by 10 feet long, with a copper jacket bonded to a steel core.

j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

3-10.02. Grounding System Resistance. The ground system resistance shall comply with National Electrical Code.

3-10.03. Grounding System Testing. The grounding system of each new building or structure shall be tested to determine the resistance to earth. Testing shall be completed after not less than three full days without precipitation and without any other moistening or chemical treatment of the soil.

3-10.03.01. New Grounding Systems. Grounding systems of each new building or structure shall be tested for resistance to earth utilizing the three-point fall of potential test as defined by IEEE 81. Testing shall be completed prior to installation of the electrical distribution equipment to ensure the grounding system is isolated from the utility grounding system and the systems of other structures. The current source probe for the test shall be placed in soil at a distance of 5 to 10 times the distance of the widest measurement across the grounding system ring or grid to ensure adequate measurements outside of the grounding system's sphere of influence. Test probe measurements shall be taken at a distance of one foot from the grounding system reference connection and at each 10 percent increment from the grounding system reference connection to the current source probe location. Test results shall be documented on a graphical plot with resistance in ohms on the vertical axis and distance in feet on the horizontal axis. The results shall clearly indicate a system resistance plateau which confirms a valid test procedure.

3.10.03.02. Existing Grounding Systems. Not used.
3.10.03.03. Grounding System Test Report. A report shall be prepared and submitted in accordance with the Submittal Procedures section. The final report shall include complete testing results for each building or structure, graphical representation of the test point results for the three-point fall of potential method, and complete observations of all site weather conditions and other environmental conditions that may affect the test results. Final acceptance of the results reported shall be subject to the review and approval of Design-Builder.

3-11. LIGHTING FIXTURE INSTALLATION. The Drawings indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.

Conduit and wire for lighting fixture installation is not shown on the Drawings and shall be sized, furnished and installed by Electrical Subcontractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for lighting fixture installation.

3-12. AUTOMATIC POWER FACTOR CORRECTION CAPACITOR UNIT INSTALLATION. Capacitor unit shall be furnished and installed as indicated on the Drawings.

3-13. HEAT-TRACED PIPING INSTALLATION. Factory inspections and tests for heat tracing cables shall include but are not limited to the following:

a. Testing shall be done in accordance with IEEE 515 test section and applicable manufacturer's standards.

b. Megger test of heater cables shall be at jobsite when received before installation.

c. Megger test of heater cables shall be performed after installation, but before insulation is applied.

d. Megger test of heater cables shall be performed after insulation has been installed.

e. All three of the above field megger readings shall be greater than 20 megohms. If any heater cable does not pass the megger test it shall be replaced at the Subcontractor's expense.

f. Field megger tests shall be recorded for each heater cable, and certified reports shall be submitted to the Design-Builder.

3-14. MODIFICATIONS TO EXISTING EQUIPMENT. Not used.

End of Section

STANDARD SPECIFICATIONS

REFERENCE: UL 83, ICEA S-95-658 (NEMA WC70).

CONDUCTOR: Solid, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, UL 83, Type THHN and THWN, ICEA S-95-658.

SHIELD: None.

JACKET: Conductor: Nylon, 4 mils (100 µm) minimum thickness, UL 83.

FACTORY TESTS: Cable shall meet the requirements of UL 83 for Type THHN and THWN.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	µm	in.	mm
12	4.0	1	0.015	380	0.17	4.32
10	6.0	1	0.020	510	0.20	5.08

*The average thickness shall be not less than that indicated above. The minimum thickness shall not be less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, THWN or THHN, conductor size, and 600 volt.

600 Volt, Single Conductor Lighting Cable (600-1-PVC-THHN-THWN)

BLACK & VEATCH	Cable Data	Figure 1-26 05 1116050

STANDARD SPECIFICATIONS

REFERENCE: ICEA S-95-658 (NEMA WC 70).

CONDUCTOR: Concentric-lay, uncoated copper; strand Class B. Wet/dry maximum operating temperature 90°C.

INSULATION: Cross-linked thermosetting polyethylene, ICEA S-95-658, Paragraph 3.6.

SHIELD: None.

JACKET: None.

FACTORY TESTS: Cable shall meet the requirements of ICEA S-95-658.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	μm	in.	mm
14	2.5	7	0.030	760	0.17	4.32
12	4.0	7	0.030	760	0.19	4.83
10	6.0	7	0.030	760	0.21	5.33
8	10.0	7	0.045	1140	0.27	6.86
6	16.0	7	0.045	1140	0.31	7.87
4	25.0	7	0.045	1140	0.36	9.14
2	35.0	7	0.045	1140	0.42	10.67
1	40.0	19	0.055	1400	0.48	12.19
1/0	50.0	19	0.055	1400	0.52	13.21
2/0	70.0	19	0.055	1400	0.57	14.48
4/0	95.0	19	0.055	1400	0.68	17.27
250	120.0	37	0.065	1650	0.75	19.05
350	185.0	37	0.065	1650	0.85	21.59
500	300.0	37	0.065	1650	0.98	24.89
750	400.0	61	0.080	2030	1.22	31.00
1,000	500.0	61	0.080	2030	1.37	34.80

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, XHHW-2, conductor size, and voltage class.

600 Volt, Single Conductor Lighting/Power Cable (600-1-XLP-NONE-XHHW-2)

BLACK & VEATCH	Cable Data	Figure 2-26 05 1116050

STANDARD SPECIFICATIONS

REFERENCE: UL 83, ICEA S-95-658 (NEMA WC 70).

CONDUCTOR: Stranded, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, UL 83, Type THHN and THWN, ICEA S-95-658.

SHIELD: None.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 83.

FACTORY TESTS: Cable shall meet the requirements of UL 83 for Type THHN and THWN.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	μm	in.	mm
14	2.5	19	0.015	381	0.12	3.05
12	4.0	19	0.015	381	0.14	3.56
10	6.0	19	0.020	508	0.17	4.32
8	10.0	19	0.030	762	0.23	5.84
6	16.0	19	0.030	762	0.26	6.60
4	25.0	19	0.040	1016	0.33	8.38
2	35.0	19	0.040	1016	0.39	9.91
1	40.0	19	0.050	1270	0.44	11.18
1/0	50.0	19	0.050	1270	0.50	12.70
2/0	70.0	19	0.050	1270	0.54	13.72
4/0	95.0	19	0.050	1270	0.66	16.76
250	120.0	37	0.060	1520	0.72	18.29
350	185.0	37	0.060	1520	0.83	21.08
500	300.0	37	0.060	1520	0.96	24.38
750	400.0	61	0.070	1780	1.17	29.72
1,000	500.0	61	0.070	1780	1.32	33.53

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, THWN or THHN, conductor size, and 600 volt.

600 Volt, Single Conductor Power Cable (600-1-PVC-THHN-THWN)

BLACK & VEATCH	Cable Data	Figure 3-26 05 1116050

STANDARD SPECIFICATIONS

REFERENCE: UL 66, UL 1277.

CONDUCTOR: 16 AWG (1.5 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 66, Type TFN.

LAY: Twisted pair with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.

SHIELD: Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 66.

Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION: One conductor black, one conductor white.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	**μm**	**in.**	**mm**
Single Pair	0.045	1140	0.34	8.64

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single pair, and voltage class.

600 Volt, Single Pair, Shielded Instrument Cable (600-SINGLE-PAIR-SH-INSTR)

BLACK & VEATCH	Cable Data	Figure 4-26 05 1116050

STANDARD SPECIFICATIONS

REFERENCE:	UL 66, UL 1277.
CONDUCTOR:	16 AWG (1.5 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.
INSULATION:	Polyvinyl chloride, not less than 15 mils (380 µm) average thickness; 13 mils (330 µm) minimum thickness, UL 66, Type TFN.
LAY:	Twisted triad with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.
SHIELD:	Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.
JACKET:	Conductor: Nylon, 4 mils (100 µm) minimum thickness, UL 66. Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.
CONDUCTOR IDENTIFICATION:	One conductor black, one conductor white, one conductor red.
FACTORY TESTS:	Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	**µm**	**in.**	**mm**
Single Triad	0.045	1140	0.35	8.87

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single triad, and voltage class.

600 Volt, Single Triad, Shielded Instrument Cable (600-SINGLE-TRIAD-SH-INSTR)

BLACK & VEATCH	**Cable Data**	**Figure 5-26 05 1116050**

STANDARD SPECIFICATIONS

REFERENCE: UL 66, UL 1277.

CONDUCTOR: 18 AWG (0.75 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 66, Type TFN.

LAY: Twisted pairs or triads with 1-1/2 inch to 3 inch (38.10 - 63.5 mm) lay.

SHIELD: Each pair or triad and cable assembly: Combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors. Shield tape on pair and/or triad assemblies shall be applied in such a way as to give total shield isolation from all other pairs' or triads' shields.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 66.

Cable Assembly: Black, 90°C, flame-retardant polyvinyl chloride, UL 1277, Table 10.17, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION:

Pair: One conductor black, one conductor white.

Triad: One conductor black, one conductor white, one conductor red.

PAIR Identification: Each pair and/or triad numbered.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		**Maximum Outside Diameter**	
	in.	**μm**	**in.**	**mm**
Number of Pairs				
4	0.045	1140	0.554	14.07
8	0.060	1520	0.749	19.02
12	0.060	1520	0.896	22.76
24	0.060	1520	1.256	31.90
Number of Triads				
4	0.060	1520	0.648	16.46
8	0.060	1520	0.823	20.99
12	0.080	2030	1.030	26.16
24	0.080	2030	1.393	35.38

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, number of pairs or triads, and voltage class.

600 Volt, Multiple Pair and/or Triad, Shielded Instrument Cable
(600-MULTI-PAIRS-TRIADS-SH-INSTR)

BLACK & VEATCH	**Cable Data**	**Figure 6-26 05 1116050**

STANDARD SPECIFICATIONS

REFERENCE: UL 83, UL 1277, ICEA S-73-532, ICEA S-58-679.

CONDUCTOR: 14 AWG (2.5 mm^2), 7 or 19 strands, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 83, Type THHN and THWN.

SHIELD: None.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 83.

Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION: ICEA S-58-679, Method 1, Table 2 or ICEA S-58-679, Method 3, Table 2. White or green conductors shall not be provided.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 83 for Type THHN-THWN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the flame test requirements of UL 1277 for Type TC power and control tray cable.

Cable Details

Number of Conductors	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	μm	in.	mm
2	0.045	1140	0.38	9.65
3	0.045	1140	0.39	9.91
4	0.045	1140	0.44	11.18
5	0.045	1140	0.46	11.68
7	0.045	1140	0.49	12.45
9	0.045	1140	0.61	15.49
12	0.060	1520	0.66	16.76
19	0.060	1520	0.77	19.56
24	0.060	1520	0.93	23.62
30	0.080	2030	0.98	24.89
37	0.080	2030	1.05	26.67

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type THWN or THHN, conductor size, number of conductors, and voltage class.

600 Volt, Multiconductor 14 AWG (2.5 mm^2) Control Cable (600-MULTI-THHN-THWN)

BLACK & VEATCH	Cable Data	Figure 7-26 05 1116050

STANDARD SPECIFICATIONS

REFERENCE: UL 83, UL 1277, ICEA S-73-532, ICEA S-58-679.

CONDUCTOR: 12 AWG (4 mm^2), 7 or 19 strands, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 83, Type THHN and THWN.

SHIELD: None.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 83.

Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION: ICEA S-58-679, Method 1, Table 2 or ICEA S-58-679, Method 3, Table 2. White or green conductors shall not be provided.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 83 for Type THHN-THWN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the flame test requirements of UL 1277 for Type TC power and control tray cable.

Cable Details

Number of Conductors	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	μm	in.	mm
2	0.045	1140	0.46	11.68
3	0.045	1140	0.49	12.45
4	0.045	1140	0.56	14.22
5	0.045	1140	0.60	15.24
7	0.045	1140	0.66	16.76
9	0.060	1520	0.77	19.56
12	0.060	1520	0.91	23.11
19	0.060	1520	1.05	26.67
24	0.060	1520	1.22	30.99
30	0.080	2030	1.29	32.77
37	0.080	2030	1.40	35.56

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type THWN or THHN, conductor size, number of conductors, and voltage class.

600 Volt, Multiconductor 12 AWG (4 mm^2) Control Cable (600-MULTI-THHN-THWN)

BLACK & VEATCH	Cable Data	Figure 8-26 05 1116050

STANDARD SPECIFICATIONS

REFERENCE: Type MC, UL 83 and 1569.

CONDUCTOR: Solid, uncoated copper. Maximum operating temperature 90°C dry.

INSULATION: Polyvinyl chloride, UL 83, Type THHN.

GROUND: Copper conductor sized per NEC with green THHN insulation.

JACKET: Conductor: Nylon.

ARMOR: Galvanized interlocked steel.

FACTORY TESTS: Conductors shall meet the requirements of UL 83 for Type THHN. Assembly shall meet the requirements of UL 1569 for Type MC.

Cable Details

Size					Nominal Outside Diameter	
AWG or kcmil	mm²	Number of Conductors	Ground Size (AWG)	Number of strands per conductor	in.	mm
12	4.0	2	12	1	0.492	12.50
12	4.0	3	12	1	0.531	13.49
12	4.0	4	12	1	0.579	14.71
10	6.0	2	10	1	0.562	14.27
10	6.0	3	10	1	0.610	15.49
10	6.0	4	10	1	0.641	16.28

600 Volt, Type MC Metal Clad Lighting Cable (Metal Clad THHN)

BLACK & VEATCH	Cable Data	Figure 14-26 05 11

STANDARD SPECIFICATIONS

REFERENCE: ICEA S-95-658 (NEMA WC 70).

CONDUCTOR: Stranded, uncoated copper. Maximum operating temperature 90°C.

INSULATION: Cross-linked polyethylene, ICEA S-95-658.

GROUND: Copper conductor sized per NEC with green insulation.

SHIELD: Cable assembly: Copper tape or aluminum foil-polyester tape, shield applied to achieve 100 percent cover over insulated conductors.

JACKET: Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

FACTORY TEST: Cable shall meet the requirements of ICEA S-95-658, UL1277 and IEEE Standard 1202 ribbon burner flame test.

Cable Details

Size		Number of Strands	*Conductor Insulation Thickness		**Assembly Jacket Thickness		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	mm	in.	μm	in.	mm
12	4	7	0.060	1.52	0.060	1520	0.66	16.80
10	6	7	0.060	1.52	0.060	1520	0.71	18.14
8	10	7	0.070	1.78	0.060	1520	0.93	23.74
6	16	7	0.070	1.78	0.080	2030	1.04	26.40
4	25	7	0.070	1.78	0.080	2030	1.21	30.67
2	35	7	0.070	1.78	0.080	2030	1.35	34.40
1	40	7	0.070	1.78	0.080	2030	1.35	34.40
1/0	50	19	0.090	2.29	0.080	2030	1.70	43.07
2/0	70	19	0.090	2.29	0.080	2030	1.77	44.94
4/0	95	19	0.090	2.29	0.110	2800	2.02	51.34
250	120	37	0.105	2.67	0.110	2800	2.30	58.49
350	185	37	0.105	2.67	0.110	2800	2.63	66.70
500	300	37	0.105	2.67	0.110	2800	3.12	79.26

*The average thickness shall be not less than indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

**The average thickness shall be not less than indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, RHW, Type TC, conductor size, and voltage class.

600 Volt, 3 Conductor Adjustable Frequency Drive Cable (600-3-AFD-XLP-PVC-SH-TC)

BLACK & VEATCH	Cable Data	Figure 15-26 05 1116050

Project and Location _____ Project No. _____

Circuit Designation _____ Date _____

DC TEST DATA

Time in Minutes After 100% Test Voltage Is Applied	Current, µA		
	Phase A	Phase B	Phase C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
kV dc after 1 min Decay			

DC Test Voltage _____

Cable Installation: New ____ Used ___ Years____

Cable: Size _____ Length: _____

Oper. kV _____ Grounded _____ Ungrounded _____

Rated Cable Voltage _____

Insulation Wall _____
(Type & Thickness)

Conductor Jacket Wall _____
Type & Thickness)

Shield _____
(Type)

Cable Manufacturer _____

Temperature _____ Humidity_____

Type of Termination _____

Type of Splice & Location_____
_____

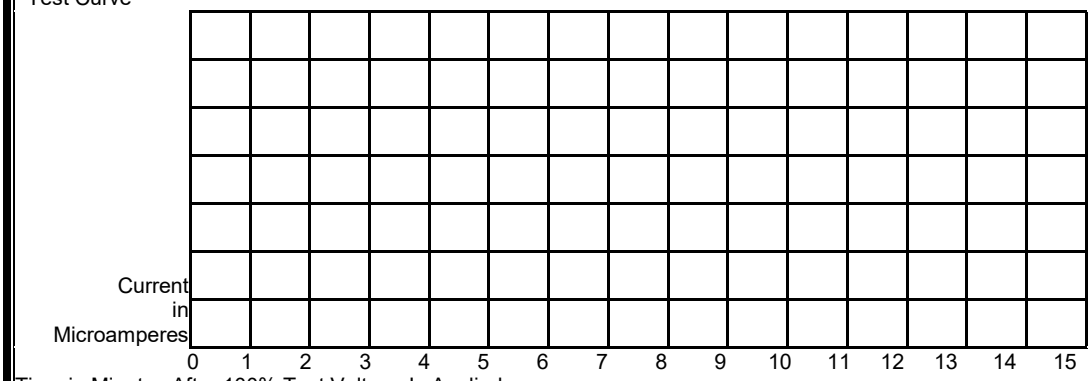
Remarks_____

100 Microamperes (µA) = 0.1 Milliampere

APPLICATION OF TEST VOLTAGE

The initially applied direct-current voltage shall be not greater than 3.0 times the rated alternating-current voltage. The rate of increase from the initially applied voltage to the specified test voltage shall be not over 100 percent in 10 seconds nor less than 100 percent in 60 seconds. The duration of the direct-current voltage test shall be 15 minutes for shielded cables and 5 minutes for nonshielded cables.

Test Curve



NOTES:
1. Plot results of tests on all three phases on this graph.
2. Assign and indicate values for each division on the microamperes scale as required for the circuit being tested.

Cable Test Data Form

BLACK & VEATCH	Cable Data	Figure 16-26 05 1116050

Section 26 05 83

ELECTRICAL EQUIPMENT INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the installation of electrical equipment.

1-2. GENERAL. Equipment specified to be installed under this section shall be erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. Coordination. When manufacturer's field services are provided by the equipment manufacturer, Design-Builder and Electrical Subcontractor shall coordinate together the services with the equipment manufacturer.

Submittals for equipment furnished by others will be furnished to Electrical Subcontractor upon completion of review by Design-Builder. Electrical Subcontractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Electrical Subcontractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

1-3. DELIVERY, STORAGE, AND HANDLING.

1-3.01. Delivery. When sills are required for electrical equipment, they shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed.

1-3.02. Storage. Upon delivery, all equipment and materials shall immediately be stored and protected by Electrical Subcontractor in accordance with Product Storage and Handling Requirements section, and in accordance with manufacturer's written instructions, until installed in the Work. Equipment shall be protected by Electrical Subcontractor against damage and exposure from the elements. At no time shall the equipment be stored on earth or grass surfaces or come into contact with earth or grass. Electrical Subcontractor shall keep the equipment clean and dry at all times. Openings shall be plugged or capped (or otherwise sealed by packaging) during temporary storage.

1-3.03. Handling. Electrical equipment shall be moved by lifting, jacking, or skidding on rollers as described in the manufacturer's instructions. Special lifting harness or apparatus shall be used when required. Lifting and jacking points shall be used when identified on the equipment. Electrical Install shall have required unloading equipment on site to perform unloading work on the date of equipment delivery.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3-1. INSTALLATION, TESTING, AND COMMISSIONING. All installation work shall be in accordance with manufacturer's written instructions.

All material, equipment, and components specified to be installed according to this section shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

Electrical equipment cubicles and vertical sections shall be installed plumb and level. Drawout equipment carriages, circuit breakers, and other removable components shall operate free and easy without binding or distortion.

Unless otherwise indicated or specified, all indoor floor-mounted electrical equipment and control cabinets shall be installed on concrete equipment pads four inches [102 mm] in height.

Motor control centers with integral floor sills shall be secured to concrete floors or equipment pads with anchor bolts.

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

3-1.01. Cleaning. All deposits of oil, grease, mud, dirt or debris shall be cleaned from the electrical equipment following installation and field wiring. A detergent water based solution, or other liquid cleaners not harmful to material or equipment finishes, shall be used as recommended by the manufacturer.

End of Section

Section 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1-1. SCOPE. This section covers switchboard equipment, which shall be furnished as specified herein and as indicated on the Drawings. Switchboards shall meet the following requirements, and the design conditions and features.

Switchboards shall be designated and located as follows:

Tag number(s)	As per Electrical One-line 80-E-701
Switchboard designation(s)	As per Electrical One-line 80-E-701
Location of switchboard(s)	As per Electrical drawing 80-E-101

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Dimensional Restrictions. Layout dimensions will vary between manufacturers, and the layout area indicated on the Drawings is based on typical values. The supplier shall review the engineering Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Design Builder.

1-2.04. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be

installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1-2.05. Governing Standards. All equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

NEMA PB 2 and UL 891 (switchboards);
NEMA AB1 and UL 489 (molded-case circuit breakers);
ICS-6 (enclosures);
NEMA PD 2.2 (Ground Fault Protection).
NEC 240.87 (Arc Energy Reduction)

The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, NEC and NFPA 70.

Equipment covered by this section shall be listed by UL.

1-2.06. Nameplates. Each switchboard section shall have a nameplate permanently affixed to it, listing the following information:

Name of manufacturer

System voltage

Main bus rating

Type

Manufacturer's shop order number and date

In addition, each circuit breaker and instrument on the front of the switchboard shall have a suitable nameplate. Each incoming line section shall be furnished with a nameplate to indicate the power source or substation from which it is fed. The nameplates for the distribution circuit breakers shall indicate the equipment fed through the breaker. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/4 inch [19 mm] high letters for section and circuit breaker identity and 1/8 inch [3 mm] letters for other information. The engraving shall extend through the black exterior lamination to the white center.

Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

1-2.07. System Characteristics. The switchboard will be connected to a power system with characteristics as specified below.

Voltage rating	480 V
Frequency	60 Hz
Type	Three phase and neutral
Grounding	Solid

1-3. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the switchboard, shall be submitted in accordance with the Submittal Procedure section. The drawings and data shall include, but shall not be limited to, the following:

Switchboard
- Elevation, plan, conduit entrance locations, and weight.
- Circuit breaker time-current characteristic curves.
- Nameplate legends and equipment schedule.
- Single-line and control wiring interconnection diagrams.
- Metering section details.
- Shop test report.
- Installation report.
- Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.

Seismic Design Requirements
- Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

Studies
- Short-Circuit Study
- Coordination Study
- Arc Flash Analysis

1-4. OPERATION AND MAINTENANCE DATA AND MANUALS. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-5. SPARE PARTS. Provide a manufacturer recommended spare part list to Design-Builder.

1-6. PROTECTIVE DEVICE STUDY. A protective device study of the power distribution system will be conducted as specified in the Electrical section. The equipment manufacturer shall provide the following information to Design Builder with the initial equipment drawing submittal:

Protective relay coordination curves for each solid-state trip device.

Time current curves shall be provided for the following circuit breakers:
Main breaker
Largest feeder breaker
Smallest breaker

Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

1-7. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

Switchboards shall be equipped to be handled by a crane. Where cranes are not available, switchboards shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

1-8. ARC FLASH HAZARD LABELS. Switchboards shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E.
Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

Additional information shall be provided on the labels as per the Arc Flash Hazard Analysis performed by the Supplier.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. The switchboard shall be manufactured by Eaton, General Electric, Schneider-Electric, or Siemens without exception.

2-2. CONSTRUCTION. All equipment furnished under this section shall be front connected, and shall be designed and constructed in accordance with the following requirements and as indicated on the Drawings.

2-2.01. Enclosure. The switchboard shall be of deadfront, modular type construction with the required number of vertical sections bolted together to form one rigid, NEMA Type 1 metal-enclosed unit. All sections shall be aligned in both

front and rear. The switchboard frame shall be of formed UL gauge steel, rigidly bolted together to support all cover plates, buses, and circuit breakers. Steel base channels shall be bolted to the frame. Each section shall have a removable top plate and an open bottom for installation and termination of conduit. All front covers shall be removable with a single tool and all doors shall be hinged, with removable hinge pins. Enclosures shall have frontaccess, and shall be designed to be installed against a wall. End sections shall include provisions for main, ground and neutral bus extensions and installation of future vertical sections.

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-2.02. Busing. The main a bus shall be tin-plated copper and shall be of sufficient size to limit the temperature rise to 65°C, based on UL tests. End sections shall be predrilled for units to be added in the future. The bus rating shall be as follows:

Bus current rating.	Per Drawing
Bus fault rating (symmetrical).	Per Drawing

2-2.02.01. Neutral Bus. Not used.

2-2.02.02. Neutral Pad. The incoming line section shall be equipped with a neutral bond lug suitable to bond the service entrance neutral conductors. The service entrance neutral pad shall be equipped with a main bonding jumper to the switchboard ground bus in accordance with the National Electrical Code.

2-2.03. Ground Bus. The ground bus shall extend the entire length of the switchboard and shall be firmly secured to each vertical section. A ground lug shall be provided at each end of the ground bus for connection to building grounding system with 4/0 AWG bare copper cables. Other ground lugs for feeder circuits shall also be supplied as indicated on the Drawings.

2-2.04. Incoming Line Sections. Incoming line sections shall be provided as shown on the one-line diagram and as specified herein.

Number of incoming line sections	1
Service entrance rated	Yes
Incoming cable entrance	Bottom

2-2.04.01. Cable Pull Box. Each bussed pull section shall have compression type terminals for the number and size of copper conductors. The cable pull box shall include provisions for a power utility seal.

2-2.04.02. Nonsegregated Phase Bus Duct Entry Compartment. Not used.

2-2.04.03. Power Utility Metering Compartment. This compartment shall meet the requirements of the local utility and shall be provided with a sealable hinged door. Busses shall include provisions for mounting utility company current transformers and potential transformers or bus taps.

2-2.04.04. Incoming Line Metering Compartment. Not used.

2-2.04.05. Surge Protective Devices.

2-2.04.05.01. Scope. Surge Protective Devices (SPD) devices shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the facility's wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.

SPD's shall be furnished and installed for the electrical equipment indicated on the Drawings and designated in this section as required and as specified herein. SPD's shall be installed integral to each switchboard. SPD's for switchboards shall be rated formedium-high exposure levels.

2-2.04.05.02. Standards. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41 and C62.45;

ANSI/IEEE C62.1 and C62.11;

IEEE C62.62;

NEMA LS1;

NFPA 20, 70, 75, and 78;

UL 1449 and 1283

The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

2-2.04.05.03. Environmental Requirements.

a. Operating Temperature: 0°F to +140°F (-18°C to +60°C).

b. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

2-2.04.05.04. Electrical Requirements.

a. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.

b. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.

c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.

d. Protection Modes. Four-wire configured systems shall provide Line-to-Neutral (L-N), Line-to-Ground (L-G), and Neutral-to-Ground (N-G), and Line-to-Line (L-L) protection. Three-wire configured systems shall provide Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.

e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be no less than as follows:

	L-N	L-G	N-G	L-L
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA

f. UL 1449 Voltage Protection Rating (VPR). The maximum VPR for the device (inclusive of disconnect) shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
480 V 4W	1200 V	1200 V	1200 V	2000 V

g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.

h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.

i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200 kA symmetrical fault current with 600 volts AC applied.

The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit.

2-2.04.05.05. Warranty. The manufacturer shall provide a standard Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

2-2.04.05.06. Installation. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

2-2.04.05.07. Accessories

a. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL1449 listed as such, and the UL1449 Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.

b. Dual Form "C" Dry Contacts. The SPD shall be provided with a set of form "C" dry contacts (normally open and normally closed) to facilitate connection to a plant control system or other remote monitoring system. The contacts shall be normally open or normally closed and shall change state upon any alarm condition.

2-2.04.06. Main Breaker. Each incoming line section shall include a fixed mounted insulated case power circuit breaker with a current rating as indicated on the Drawings and with a manually operated stored energy mechanism. Molded case circuit breakers shall have solid state electronic with short time delay trip mechanisms, and shall have ground fault protection.

Compression type terminals shall be provided for terminating the number and size of copper conductors indicated on the Drawings.

2-2.05. Tie Breaker Section. Not used.

2-2.06. Distribution Section. The distribution section shall be provided to house branch circuit breakers as indicated on the Drawings.

Circuit breakers shall be removable from the front without disturbing adjacent units. The switchboard shall contain space for future units as indicated on the Drawings. The cable entry for the distribution section shall be from the bottom.

2-2.07. Molded Case Circuit Breakers. Circuit breakers shall be rated to interrupt and withstand an available fault current of 65,000 A at the system line voltage. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically trip free. Circuit breakers shall have trip units as specified herein. Electronic trip units shall be complete with built-in current transformers. The ampere rating of the trip unit shall be as indicated on the Drawings.

The trip unit shall have adjustable settings for continuous amperes, instantaneous pickup, and short-time pickup. Where specified herein, the trip unit shall be provided with additional short delay trip time adjustment for better system coordination. Circuit breakers indicated to be rated less than 100 amperes shall be thermal-magnetic types.

Where specified herein, built-in ground fault protection shall be provided having adjustable pick-up ratings not exceeding 1,200 amperes, time delay adjustable from 0.1 to 0.5 seconds, and a neutral ground fault current transformer.

Solid-state electronic trip breakers shall have built-in test points for testing long delay, instantaneous, and ground fault functions of the breaker by means of a 120 volts AC operated test kit.

2-2.08. Insulated Case Power Circuit Breakers. Insulated case breakers shall be UL listed for operation at 100 percent of continuous current rating. The circuit breakers shall be rated to interrupt and withstand an available fault current of65,000 A at system line voltage. The breaker control faceplate shall include color-coded visual indicators for open and closed positions as well as mechanism charged and discharged positions. Manual push buttons shall be provided for opening and closing the breaker. Internal control power transformers shall be provided to furnish control power for insulated case power circuit breakers

Each breaker shall be furnished with a solid-state tripping system consisting of three current sensors, a solid-state trip device, and shunt trip. The solid-state element shall have long delay current pickup, short delay pickup, instantaneous pickup, ground fault pickup and fault trip indicators. All elements of the solid-state trip device shall be of the sealed potentiometer type providing adjustable current pickup in percentage of current sensor primary rating and time delay adjustments. The current sensor primary ampere rating shall be as indicated on the Drawings.

The breaker shall have built-in test points for testing long delay, short delay, instantaneous, and ground fault functions of the breaker by means of a 120 volts AC operated test kit.

2-2.09. Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings.

2-2.10. Arc Energy Reduction. Arc energy mitigation system shall be provided for the equipment as per the NEC 240.87 requirements.

2-3. SHOP TESTS. After the equipment has been completely assembled, it shall be shop tested for general operating conditions, circuit continuity, and high potential and other standard tests for the particular class of equipment as defined by industry standards. Four certified copies of the test results shall be submitted to Design Builder before the equipment is shipped.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with the Electrical Equipment Installation section.

3-2. TRAINING. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

Section 26 24 23

600 VOLT CLASS MOTOR CONTROL CENTERS

PART 1 - GENERAL

1-1. SCOPE. This section covers motor control center (MCC) equipment which shall be furnished and installed as specified herein and as indicated on the Drawings. Motor control centers shall meet the following requirements, and the design conditions and features specified herein.

Motor control centers shall be designated and shall be located as follows:

Tag number(s)	Per the electrical one-line drawings, 50-E-701 to 702, 80-E-701 to 704
Motor control center designation(s)	Per the electrical one-line drawings above
Location of motor control center(s)	Per the electrical drawings

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless Design Builder notes exceptions.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.02. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Design Builder.

1-2.03. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except when required by tests.

1-2.04. Governing Standards. All equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

NEMA ICS 18
UL 845.
NEC 240.87 (Arc Energy Reduction)

The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, NEC, and NFPA 70.

Equipment covered by this section shall be listed by UL.

1-2.05. Nameplates. Nameplates with unit description and designation of each control or indicating device shall be provided on all hinged doors. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch [10 mm] high letters for compartment identity and 3/16 inch [5 mm] letters for other information. The engraving shall extend through the black exterior lamination to the white center.

Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1-2.06. System Characteristics. This equipment will be connected to a power system with characteristics as specified below.

Voltage	480 V
Frequency	60 Hz
Type	Three phase

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor control center shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Motor Control Center

Elevation, plans, and weight.
Unit wiring diagrams showing devices, connections, and terminal designations.
Interconnection diagrams.
Control schematic diagrams.
Circuit breaker time-current characteristic curves.
Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

Studies

Short-Circuit Study
Coordination Study
Arc Flash Analysis

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. SPARE PARTS. Provide a manufacturer recommended spare part list to Design-Builder.

1-5. PROTECTIVE DEVICE STUDY. A protective device settings study of the power distribution system will be conducted in accordance with the Electrical section. The initial equipment drawing submittal shall include the circuit breaker coordination curves for the main breaker, the largest circuit breaker utilized in a combination starter and the smallest circuit breaker provided as a part of the motor control center assembly.

1-6. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and Storage shall be in accordance with the manufacturer recommendations and this Section.

Motor control centers shall be equipped to be handled by a crane. Where cranes are not available, control centers shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

1-7. Arc Flash Hazard Labels. Switchboards shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E.
Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

Additional information shall be provided on the labels as per the Arc Flash Hazard Analysis performed by the Supplier.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. The equipment shall be manufactured by Allen-Bradley, Eaton, General Electric, Schneider-Electric, or Siemens without exception.

2-2. CONSTRUCTION. Each control center shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the Drawings or specified herein. End sections shall include provisions for main, ground and neutral bus extensions and installation of future vertical sections.

Motor control center wiring shall be NEMA Class ISand NEMA Type B.

See electrical drawings for the MCC tags, bus sizes and rating. All MCC enclosure shall be NEMA Type 1.

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-2.01. Outdoor Enclosures. Not used.

2-2.02. Vertical Sections. The control center shall consist of standardized, freestanding structures bolted together to form a single dead-front panel assembly containing combination motor control units; feeder units; transformers; lighting panels; and metering, relaying, and interlocking, and miscellaneous control devices, as indicated on the Drawings. A removable lifting angle shall be mounted on the top of each shipping group. Removable front and rear bottom channel sills shall extend the full width of the motor control center.

Each vertical section shall be 90 inches [2250 mm] high and not less than 20 inches [500 mm] wide. Sections shall be 20 inches [500 mm] deep. Each 20 inch wide standard section shall have all necessary hardware and busing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Removable rear plates shall be sectionalized so that it is unnecessary to handle any plate larger than the section width or one-half the section height.

A metal barrier extending the full height and depth of the section shall be provided to isolate each section from the next section.

2-2.03. Compartmented Units. Each vertical section shall be constructed of modular components of various sizes. The modular components shall be designed to accommodate not more than six Size 1 or Size 2 full voltage combination motor starters per vertical section.

Removable circuit breaker and motor starter units shall be provided with a mechanical interlock to prevent insertion or withdrawal when in the "on" position.

Individual motor starter units, feeder breaker units, transformers, lighting panels, and control device compartments shall be isolated from each other by barriers of metal or a suitable insulating material.

Each vertical section shall have a vertical-wiring trough for power and control wiring, and wiring troughs on top and bottom, which are continuous through the entire control center. Wire ties shall be provided in the vertical wireways unless the wireways are separated from the plug-in units by a permanent wall.

2-2.04. Wiring Labels and Terminal Blocks. All internal wires shall be labeled at each termination. Terminals shall also be identified with labels showing the terminal block and terminal number.

All starter units shall be provided with unit control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.

2-2.05. Busing. The horizontal main bus and the vertical bus extensions shall be tin-plated copper mounted on supports formed of materials having high dielectric strength, low moisture absorbency, and high impact strength. The main bus shall extend the full length of the motor control center and shall have provisions for splicing additional sections onto either end. Both horizontal and vertical busing shall be braced against forces resulting from fault current.

The vertical bus connecting an incoming power feeder cable shall have the same ampere rating as the main horizontal bus. Each vertical bus extension shall be rated for the total connected load of the vertical section.

A tin-plated copper ground bus rated 300 amperes shall extend through the entire control center and shall be located where it will not interfere with pulling of external cable. Grounding connections shall be accessible from the front. The ground bus shall be provided with six 0.38 inch [10 mm] holes for each vertical section to accept ground lugs for any loads requiring a ground conductor. A solderless connector shall be provided on the ground bus in each end section for an external ground cable, sized from 1/0 AWG to 250 kcmil [50 to 120 mm^2].

Each vertical section shall have a vertical ground bus. The plug-in units shall engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected.

2-2.05.01. Neutral Bus. Not used.

2-2.05.02. Neutral Pad. The incoming line section shall be equipped with a neutral bond lug suitable to bond the service entrance neutral conductors. The service entrance neutral pad shall be equipped with a main bonding jumper to the control center ground bus in accordance with the National Electrical Code.

2-2.06. Isolation of Buses. The main bus shall be isolated from the horizontal wiring trough. The entire vertical bus assembly shall be enclosed within grounded steel or glass filled polyester barriers. The barriers shall have openings for power stabs of plug-in units. Shutters shall be provided to close the openings when units are removed.

2-2.07. Combination Magnetic Starters. As indicated on the Drawings, control center starters shall be breaker combination, magnetic, reduced voltage, or across-the-line type as follows:

a. Starters shall be 3 phase, 60 Hz contactors with overloads, a 120 volts ac coil, a dry type control transformer, and a molded-case circuit breaker. Control transformers shall be mounted with the removable starters and shall have capacity for all simultaneous loads. Control transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

b. Contactors shall be NEMA rated and have an 8 hour current rating in accordance with the latest NEMA standards. Contactors of reversing or multispeed starters shall be mechanically and electrically interlocked.

c. One NO and one NC spare interlock contacts, whether on the starter or a relay, shall be wired separately to the unit terminal board.

d. Heaterless overload protection shall be provided by three current sensors monitored by a microprocessor. The overload device shall also include phase loss and unbalance protection, trip class selection, Class II ground fault protection, and manual reset.

e. An external manual breaker operating handle with provisions for up to three padlocks shall be provided on each starter. The access door shall be interlocked with the circuit breaker so that the door cannot be opened, except by an interlock override, while the breaker is closed.

f. Supplier shall match control transformers, overloads, and minimum sizes of starters to equipment furnished, which may differ from the estimated values indicated on the Drawings. Overload relay elements shall be sized to reflect reduced motor current caused by load-side power factor correction capacitors.

g. Unless otherwise specified, spare starters shall have breakers and overloads sized for the largest rated motor and 100 watts extra transformer capacity.

2-2.08. Combination Solid-State Starters. As indicated on the Drawings, control center starters shall be breaker combination, solid-state, reduced voltage type. Six back-to-back silicon controlled rectifiers shall be used to provide smooth, stepless motor acceleration. When the motor reaches full speed, a bypass contactor shall close and carry the continuous duty motor current.

a. Starters shall be 3 phase, 60 Hz, with overloads, a 120 volts ac bypass contactor coil, a dry-type control transformer, and a molded-case circuit breaker. Control transformers shall be mounted with the removable starters and shall have capacity for all simultaneous loads. Control transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

b. The bypass contactor shall have an 8 hour current rating in accordance with the latest NEMA standards.

c. One NO and one NC spare interlock contacts, whether on the starter or on a relay, shall be wired separately to the unit terminal board.

d. Starters shall include smooth starting and stopping, adjustable starting torque, adjustable ramp time, inverse time overload current trip, current limit, phase loss protection, and adjustable electronic overloads.

e. An external manual breaker operating handle with provisions for up to three padlocks shall be provided on each starter. The access door shall be interlocked with the circuit breaker so that the door cannot be opened, except by an interlock override, while the breaker is closed.

f. Supplier shall match control transformers, overloads, and the minimum sizes of starters to equipment furnished, which may differ from the estimated values indicated on the Drawings. Overload relay devices shall be adjusted to reflect reduced motor current caused by load-side power factor correction capacitors.

g. Unless otherwise specified, spare starters shall have breakers and overloads sized for the largest rated motor and 100 watts extra transformer capacity.

h. Starters shall include an auxiliary contactor for connection to a line-side power factor correction capacitor. The contactor shall be interlocked to prevent the capacitor from being connected before the bypass contactor has energized.

2-2.09. Variable Frequency Drives. Variable frequency drives shall be provided in the size and quantity shown on the Drawings and shall be in accordance to the specification 26 29 24. Each adjustable frequency drive shall be coordinated with the requirements of the driven equipment. Particular attention shall be directed toward the driven equipment torque requirements.

The motor control center supplier shall be responsible for coordinating the drive with the driven equipment to assure compatibility between the drive and motor. All equipment shall be derated as recommended by the drive and motor manufacturers for reduced speed operation with a variable frequency controller in addition to any derating requirements specified elsewhere.

Each VFD shall be provided with an external manual breaker operating handle with provisions for up to three padlocks.

2-2.10. Contactors. Contactors for control of bus voltage loads other than motors shall be the same as contactors for combination magnetic starters, except overloads will not be required. Mechanically held contactors shall have 120 volts ac coils with disconnecting contacts. Other contactors shall have 120 volt, continuous duty coils and contacts where indicated on the Drawings.

2-2.11. Relays and Timers. Auxiliary relays and timers shall have 120 volt, 60 Hz coils for continuous duty in 40°C ambient, and 10 ampere, 120 volts ac contacts. Auxiliary relays shall be NEMA rated.

2-2.12. Control Switches and Pilot Lights. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.

2-2.13. Circuit Breakers. Control center disconnects shall be three pole, single-throw, 600 volt, molded-case air circuit breakers. Circuit breakers of combination starters shall be magnetic motor circuit protector type. Feeder circuit breakers shall be thermal-magnetic type and shall be manually operated, with quick-make,

quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration. Thermal elements shall trip the breaker at 125 percent of trip rating. The instantaneous elements of 225 ampere frame and larger breakers shall be adjustable and shall be set at 800 percent of trip rating.

Main circuit breakers and feeder circuit breakers 225 amperes and larger shall be furnished with a solid-state trip unit complete with built-in current transformers. The ampere rating of the trip unit shall be as indicated on the Drawings. The trip unit shall have adjustable settings for continuous amperes, and short-time pickup. The trip unit shall be provided with additional short delay trip time adjustment for better system coordination. Main circuit breakers shall be provided with instantaneous pickup and integral ground fault protection with shunt trip devices.

Each feeder circuit breaker shall be provided with an external manual breaker operating handle with provisions for up to three padlocks.

2-2.14. Surge Protective Devices.

2-2.14.01. Scope. Surge Protective Devices (SPD) shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the facility's wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.

SPD’s shall be furnished and installed for the electrical equipment indicated on the Drawings and designated in this section and as specified herein. SPD’s shall be installed integral to each MCC and MCC panelboard.

2-2.14.02. Standards. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41 and C62.45;

ANSI/IEEE C62.1 and C62.11;

NEMA LS1;

NFPA 20, 70, 75, and 78;

UL 1449 and 1283

The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

2-2.14.03. Environmental Requirements.

a. Operating Temperature: 0°F to +140°F [-18°C to +60°C].

b. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

2-2.14.04. Electrical Requirements.

a. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.
b. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.
c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.
d. Protection Modes. Four-wire configured systems shall provide Line-to-Neutral (L-N), Line-to-Ground (L-G), Line-to-Line (L-L), and Neutral-to-Ground (N-G) protection. Three-wire configured systems shall provide Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.
e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and shall be no less than listed in the following table. Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

f. UL 1449 Voltage Protection Rating (VPR). The maximum VPR for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
480 V 3W		1200 V		2000 V

g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.
h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.
i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200kA symmetrical fault current with 600 volts ac applied.
At medium and low exposure levels, the SPD shall incorporate internal

fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.
The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit.

2-2.14.05. Warranty. The manufacturer shall provide a standard Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

2-2.14.06. Installation. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

2-2.14.07. Accessories.

a. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL1449 listed as such, and the UL1449 Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding the published maximum surge current magnitude without failure or damage to the switch.

b. Dual Form "C" Dry Contacts. Not used

2-2.15. Incoming Line Metering Compartment. The incoming line section(s) shall be provided with a microprocessor-based, digital power meter. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Phase currents, phase voltages, watts, vars, power factor, frequency, watt-hours, watt demand, and total harmonic distortion waveforms shall be available for display. Metering units shall also include a display with touch screen monitor on the front of the equipment. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of Ethernet/IP communication for remote monitoring.

Sufficient lengths of communication cable shall be provided for connection of metering units within the motor control center.

2-2.16. Miscellaneous. Other items indicated on the Drawings shall conform to the applicable provisions of NEMA ICS 2 and UL 845.

2-2.17. Lighting Transformers. Lighting and auxiliary power transformers shall be dry type, with at least two full capacity taps.

2-2.18. Panelboards. Panelboards shall have a main circuit breaker, buses, bolted thermal-magnetic breakers, and provisions for breakers in the sizes, quantities, and poles indicated on the Drawings. Breakers shall indicate "On", "Off", and "Tripped". Breakers indicated to be multiple pole shall be common trip. Circuit breakers shall be fully rated, with an interrupting rating of at least 10,000 amperes, and shall be coordinated with the control center short-circuit rating. The panel shall have main and neutral buses insulated from the enclosure, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the enclosure, and a removable bond to the neutral bus. Each panel shall be provided with a typewritten directory listing the load identities of all circuits. Six breaker handle clips shall be provided to prevent casual tripping. Panelboards shall be 120/208 V, 3-phaseand 480 V, 3-phase, 3W as per the drawings.

Power panels shall have SPD's rated for a medium exposure levels. Lighting panels shall have SPD's rated for a low exposure levels.

2-2.19. Special Panels. Not used.

2-2.20. Shop Painting. All iron and steel surfaces, except stainless steel and machined surfaces, shall be plated or shop painted with the manufacturer's standard coating. Finish color for both indoor and outdoor equipment shall be ANSI 61. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

2-2.21. Space Heaters. Not used.

2-2.22. Arc Energy Reduction. Arc energy mitigation system shall be provided for the equipment as per the NEC 240.87 requirements.

2-3. SHOP TESTS. The complete control center shall be tested at the factory. All circuits, including power and control, shall be given dielectric tests in accordance with NEMA ICS 2-322.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with the Electrical Equipment Installation section.

3-2. TRAINING. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

Section 26 29 24

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1-1. SCOPE. This section covers pulse width modulated (PWM) type variable frequency drives (VFD) for the equipment and locations as specified. VFDs shall meet the design conditions and features specified herein.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected(ship-loosed VFD shall be installed by Design-Builder), and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer.

VFDs shall be designed, manufactured, supplied, and warranted as a complete system by the VFD manufacturer. Fabrication and assembly of the drive system not directly controlled by the VFD manufacturer will not be acceptable.

1-2.01. Coordination. The design of the variable frequency drive shall be coordinated with the driven equipment. Electrical Subcontractor shall be responsible for coordinating the collection of data and the design effort to limit harmonics to the levels specified.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Design-Builder.

1-2.05. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1-2.06. Governing Standards. The adjustable frequency drive shall be designed, constructed, and tested in accordance with the applicable standards of NEMA, ANSI, UL, and IEEE, and shall be designed for installation in accordance with the NFPA 70.

The equipment covered by this section shall be listed by UL.

1-2.07. Nameplates. Nameplates with the description and designation of each control or indicating device shall be provided. Unless specified otherwise, each drive enclosure shall be provided with a nameplate bearing the unit designation as indicated above. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch [10 mm] high letters for the drive designation and 3/16 inch [5 mm] letters for other information. The engraving shall extend through the black exterior lamination to the white center.

Each control device and each control wire terminal block connection inside the enclosure shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1-3. DESCRIPTION. The VFD shall produce an adjustable ac voltage/frequency output and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

1-3.01. Six-Pulse Drives. Drives for motors rated below 100 horsepower, shall be of the pulse-width modulated type and shall consist of a full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.

The drive inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by six identical base driver circuits. The drive shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1-3.02. Eighteen-Pulse Drives and Active Front End Drives. Drives for motors rated 100 horsepower and above, shall be eighteen-pulse or active front end type.

1-3.02.01. Eighteen-Pulse Drives. Eighteen-pulse drives shall be of the pulse-width modulated type and shall consist of an 18-pulse, full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.

The phase shifting transformer required to produce the phase shifted input to the 18-pulse rectifier shall be factory wired and mounted within the drive enclosure as an integral part of the drive assembly. External transformers shall not be required.

The VFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1-3.02.02. Active Front End Drives. Active front end drives shall be of the pulse-width modulated type and shall consist of an active front end with insulated gate bipolar transistors (IGBTs). Incoming power shall be filtered by an integral inductor-capacitor-inductor (LCL) filter. The filter shall filter out the high frequency content of the IGBT front end. The drive shall be able to boost the incoming voltage by 20% and ride through voltage dips of 35%. Power factor shall be adjustable as leading or lagging by up to 20%. The main control board for the IGBT input shall be identical to the main control board for the IGBT output. The drive shall be equipped with an integral input contactor that opens when the drive is not running and closes when a drive run signal is initiated.

The VFD inverter output shall be generated by IGBTs which shall be controlled by identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1-4. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the drive shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

a. Name of manufacturer.

b. Types and model numbers.

c. Rated drive input kVA and output kVA.

d. Percent efficiency at 100 percent speed and 60 percent speed.

e. Maximum Btu [kJ] heat release data and verification of the drive cooling requirements.

f. Total weight and lifting instructions, height, mounting, and floor space required.

g. Panel interior and front and side exterior view details showing maximum overall dimensions of all transformer, bypass contactor, ac line filter, ac line reactor, and drive compartments.

h. Schematics, including all interlocks.

I. Wiring diagrams, including all internal and external devices and terminal blocks.

j. Locations and sizes of electrical connections, ground terminations, and shielded wires.

k. List of diagnostic indicators.

l. List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.

m. List of standard features and options.

n. List of spare parts to be furnished.

o. Input line protection model numbers and manufacturer's data sheets.

p. Output filter model number and manufacturer's data sheets.

q. UL 508C Certificate of Compliance for short circuit current rating.

r. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-5. OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section.

Operation and maintenance manuals shall include the following:

a. Manufacturer's operation and maintenance manual for each size of adjustable frequency drive.

b. Manufacturer's standard manuals for each size and type of bypass contactor, transformer, line reactor, and filter.

c. Schematics, wiring diagrams, and panel drawings in conformance with construction record.

d. Model numbers and up-to-date cost data for spare parts.

e. Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.

f. Connection data to permit removal and installation of recommended smallest field-replaceable parts.

g. Information on testing of power supplies and printed circuit boards and an explanation of the drive diagnostics.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-6. SPARE PARTS. Provide a manufacturer recommended spare part list to Design-Builder.

1-7. PROTECTIVE DEVICE STUDY. A protective device study of the power distribution system will be conducted as specified in the Electrical section. The equipment manufacturer shall provide the following information to Design Builder with the initial equipment drawing submittal:

Protective relay coordination curves for each solid-state trip device.
Time current curves for each circuit breaker.

Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

1-8. Arc Flash Hazard Labels. Switchboards shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E.
Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

Additional information shall be provided on the labels as per the Arc Flash Hazard Analysis performed by the Supplier.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. All drives shall be pulse-width modulated type, as manufactured by ABB, Eaton, Rockwell Automation, Siemens W-Series, Schneider-Electric, or Toshiba without exception. Active front end drives shall be as manufactured by ABB without exception. The products of other manufacturers will not be acceptable.

All VFDs shall be a product of the same manufacturer.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS.

2-2.01. Performance. The variable frequency drive controller shall be of sufficient capacity and shall produce a quality output waveform for stepless motor control from 10 to 100 percent of base speed. See Electrical drawings for the VFD load type and voltage for each piece of equipment.

The VFD's shall be suitable for operation at an elevation below 3300 ft and shall meet the following ratings and parameters:

Input frequency	60 Hz
Input voltage and frequency variation	±10 percent voltage variation, ±2 Hz; imbalance, 2 percent maximum. Continued operation with additional momentary 25 percent voltage dip of 0.5 second duration from nominal input voltage level.
Minimum drive efficiency	95 percent at 100 percent speed, 90 percent at 60 percent speed.
Ambient temperature	0 to 40°C.
Relative Humidity	0 to 95 percent non-condensing.
Displacement Power Factor	95 percent or higher throughout the entire operating speed range, measured at drive input terminals.
Drive service factor	1.0.
Overcurrent capability	110 percent for 1 minute for variable torque; 150 percent for 1 minute for constant torque.
Volts/Hz ratio	Voltage varies as the square of frequency over the entire range of the unit for variable torque drives, linear over the entire range of the unit for constant torque drives; except under voltage boost condition.
Acceleration/deceleration time	Adjustable over a range that meets the requirements of the drive equipment.
Output speed regulation	0.5 percent.
Output frequency stability	0.5 percent of nominal.

2-2.02. Adjustments. The following drive adjustments shall be provided:

Maximum speed.

Minimum speed.

Linear acceleration time.

Linear deceleration time.

Volts/Hz ratio; linear, squared, and automatic settings.

Voltage boost.

Process follower gain, offset, and bias.

Torque limit.

Critical frequency avoidance with adjustable bandwidth.

2-2.03. Fault Protection. Design of the power circuit shall include provisions for protection against fault conditions as follows.

2-2.03.01. Input Protection.

The drive assembly shall be UL 508C listed. A UL Certificate of Compliance shall be submitted to confirm product compliance with UL 508C and to indicate the short circuit current rating. The short circuit current rating shall meet or exceed the available short circuit current indicated on the Drawings.

Solid state instantaneous overcurrent trip set at 180 percent.

Adjustable overvoltage and undervoltage protection with automatic restart.

Phase loss and reverse phase trip with manual restart.

2-2.03.02. Internal Protection.

AC line, phase-to-phase transient voltage surge suppression utilizing metal oxide varistors. Drive shall meet the requirements of IEEE C62.41.

Power device snubbers.

Power devices rated 2.5 times line voltage.

Instantaneous overcurrent.

Static overspeed (overfrequency) protection.

DC bus overvoltage trip.

Components and labeling that comply with UL 508 requirements. Drives shall be equipped with an automatic discharge circuit to deplete the charge on the DC capacitor bank to less than 50 volts within 60 seconds after main input power is removed. Labels indicating derivative voltage sources and required wait time for servicing after power removal shall be placed on all applicable enclosures.

Individual transistor overtemperature and overcurrent protection.

Control logic circuit malfunction indication.

2-2.03.03. Output Protection.

Inverse-time motor overload protection adjustable from 10 percent to 100 percent.

Overvoltage protection.

Overfrequency protection.

Short circuit protection (three phase, phase to phase, and ground fault protection).

Protection against opening or shorting of motor leads.

Static overspeed protection.

Stall protection on overload with inverse time overcurrent trip, adjustable current limit from 10 percent to 120 percent.

2-3. CONSTRUCTION.

All MCC mounted VFD's shall follow the MCC enclosure NEMA rating. All non-MCC mounted VFD's located in electrical room shall be NEMA Type 1. All non-MCC mounted VFD's located in the process area shall be NEMA Type 12. All non-MCC mounted VFD's located in outdoors shall be NEMA 4.

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-3.01. Fabrication and Assembly. The adjustable frequency drive system shall be shop assembled in a single enclosure using interchangeable plug-in printed circuit boards and power conversion components wherever possible. Shop assembly shall be performed by the drive manufacturer, or a manufacturer approved assembly center under the direction and control of the drive manufacturer; systems fabricated, assembled, and supplied in whole or in part by parties other than the drive manufacturer will not be acceptable. Changes to the drive manufacturer's product by a distributor or system integrator are not allowed.

Input line reactors, fuses, circuit breakers, and filters, where required, shall be mounted within the drive enclosure, without exception. Isolation/voltage

matching transformers, where required, may be enclosed separately from the remaining drive equipment.

The variable frequency drive system shall be designed to fit in the space indicated on the Drawings.

2-3.02. Wiring. Internal cabinet wiring shall be neatly installed in wireways or with wire ties where wireways are not practical. Where wireway is used, they are to be mounted to the panel surface with a continuous run of industrial two-sided adhesive strip. For 12 AWG wire sizes and smaller, and in bundles of six or less, wire tie-down square mounting straps shall be permitted. Tie-down mounts shall be installed at 8” increments or less. All mounting surfaces shall be pre-cleaned with isopropyl alcohol to ensure proper adhesion over the life of the equipment.

Terminal blocks shall be non-brittle, interlocking, track-mounted type, complete with a marking strip, covers, and pressure connectors. Screw terminals will not be acceptable. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. In freestanding panels, 8 inches [200 mm] of clearance shall be provided between terminals and the panel base for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Terminals shall be labeled to agree with the identification on the submittal drawings. Each control loop or system shall be individually fused, clearly labeled, and located for ease of maintenance.

All grounding wires shall be attached to the sheet metal enclosure with a ring tongue terminal. The surface of the sheet metal shall be prepared to ensure good conductivity and corrosion protection.

Wires shall not be kinked or spliced and shall be color coded or marked on both ends. The markings or color coding shall agree with the submittal drawings.

With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for at least 600 volts, with a moisture-resistant and flame-retardant covering rated for at least 90°C.

2-3.03. Enclosures. The drive shall consist of factory mounted and wired components within an enclosure, arranged so no electrically live components, terminals, or conductors are accessible on the front panel or door when the enclosure door is open.

The complete drive package, including accessories, shall fit into the space indicated on the Drawings.

Freestanding panels shall be suitable for mounting on a concrete pad and shall include provisions for anchoring to the supporting structure. Suitable lifting facilities shall be provided for handling and shipment.

Relays, terminals, and special devices inside the control enclosure shall have permanent markings to match the identification on the manufacturer's wiring diagrams.

2-3.04. Printed Circuit Boards.

All plug-in type boards shall be mechanically held at the circuit board connector. Compression fit only at the connector will not be acceptable.

2-3.05. Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop cleaned in accordance with the coating manufacturer's recommendations, and finished with the drive manufacturer's standard coating. Finish color shall be manufacturer's standard color. Dry film thickness of the finish coat shall be at least 4 mils [100 µm]. Field painting, other than touch up, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings.

All intermediate and finish coating materials shall be fumeproof and suitable for a wastewater treatment plant atmosphere that contains hydrogen sulfide. Documentation verifying that the coating material is fumeproof shall be submitted. Coatings shall be lead-free and mercury-free.

2-4. OPTIONAL EQUIPMENT. Not used.

2-5. CONTROLS.

2-5.01. Features. Each drive shall include the following features in addition to those indicated on the Drawings:

a. A door mounted membrane keypad with integral two-line, 24 character minimum LCD display that is capable of controlling the AFD and setting drive parameters. The keypad module shall be programmed with factory set drive parameters in nonvolatile EEPROM or FLASH memory and shall be resettable in the field through the keypad.

b. Control switches and pilot lights shall be provided as indicated on the schematic diagrams. Manual-automatic and start-stop controls included as features of the drive keypad shall be password protected or disabled to prevent override of control switches and safety interlocks shown on the schematic diagrams.

c. Not Used

d. Not Used

e. Input thermal-magnetic molded-case circuit breaker disconnect with interrupting capacity rated in RMS symmetrical amperes as

required, and labeled in accordance with UL standard 489. The disconnect shall be mounted inside the controller enclosure and shall have door interlocks and a handle with provisions for padlocking in the "Off" position.

f. Manual speed adjustment.

g. Indications of power "On", drive "Run", and drive "Fault". Indication of these parameters shall be provided by full voltage type LED pilot lights. Lamps shall be easily replaceable from the front of the indicating light.

h. Not Used

i. Speed indication - calibrated in percent rpm.

j. Control circuits of not more than 115 volts supplied by internal control power transformers. Control power transformers shall have additional capacity as required by external devices indicated on the Drawings. Control power transformers shall be equipped with two primary leads fused, one secondary lead fused, and one secondary lead grounded.

k. Automatic controller shutdown on overcurrent, overvoltage, undervoltage, motor overtemperature and other drive fault conditions. Controller shutdown shall be manually reset type. Terminals shall be provided for control wiring from motor temperature switches, or a motor protection relay located in the drive enclosure.

l. Diagnostic indicators that pinpoint failure and fault conditions. Indicators shall be manually reset to restore operation after abnormal shutdown.

m. Accept a remote 4-20 mA speed control signal.

n. Process control output for remote 4-20 mA speed indication, rated 0 to 100 percent speed.

o. Spare interlock contacts rated 5 amperes at 120 volts ac, wired separately to the unit terminal board. One NO and one NC isolated spare interlock shall be furnished with each drive. Additional interlock contacts shall be provided as indicated on the Drawings.

p. Drive fault and run status contacts for remote indication, rated 5 amperes at 120 volts ac.

q. Speed droop feature, which reduces the speed of the drive on transient overloads. The drive shall return to set speed after the transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive shall automatically compensate to prevent drive trip.

r. Individual adjustable speed profile settings for start, stop, entry,

slope, and minimum and maximum speed points.

s. Coast, controlled ramp, or dc injection selectable modes of stopping.

t. Not used.

u. Adjustable PWM carrier frequency. The inverter output section shall be provided with adjustable PWM carrier frequency from 500 Hz to at least 8 kHz.

v. Noise level of installed equipment shall not exceed 85 dB, as measured by an appropriate calibrated instrument. The required sound level limit shall be met at a minimum of four locations, each not more than 3 feet [0.9 m] above the floor and not more than 10 feet [3 m] from the equipment. This requirement shall apply to all drives, motors, filters, reactors, and transformers supplied with the drive.

2-5.02. Diagnostics. Diagnostic indicators on the face of the drive shall display the type of fault responsible for drive shutdown, warning, or failure. If two or more faults occur simultaneously, the diagnostic segment shall record or indicate each condition. The drive shall be capable of storing 6 events.

2-5.03. Motor Protection Relay. Not used.

2-6. TESTING. All power switching components shall be pre-run under anticipated operating temperature and load conditions. Any alternative testing procedures shall be submitted and pre-approved before proceeding.

2-6.01. Factory Testing. After the drive system has been assembled at the manufacturer's facility, it shall be tested for at least 4 hours before it is shipped. The complete drive system, including all peripherals, shall be factory tested under simulated operating conditions, including normal operating sequences and fault conditions. Contact closure inputs and simulated driven-outputs shall be connected to the system input/output modules.

A test report summary indicating satisfactory final test results shall be submitted to Design-Builder before shipment of the equipment.

2-6.02. Secondary Factory Testing. Section 2-6.02 shall only be applicable to the Equipment Supplier who is furnishing both the drive and the driven equipment within the same procurement package. The drive units shall be assembled with the driven equipment for shop testing. The drive manufacturer shall provide the services of a qualified representative to work with the equipment manufacturer at the equipment manufacturer's facility. The representative shall advise and assist in assembling and testing the equipment and drive unit packages.

Personnel conducting the tests shall be competent, authorized representatives of the equipment and drive manufacturers who are familiar with operation of the equipment furnished and who have satisfactory experience in conducting similar tests. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results. Five copies of the report shall be submitted in accordance with the Submittal Procedures section. The information collected shall be used as a basis for determining acceptability of the manufacturer's test results. In case of conflict, interpretations and calculations made by Design-Builder will govern.

Testing shall be conducted in a manner acceptable to Design-Builder. At least 2 weeks before the proposed testing date, the Design-Builder shall be notified of the testing date and shall submit a report from the equipment manufacturer detailing the proposed performance testing.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with Electrical Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Commissioning Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. FIELD HARMONIC DISTORTION TEST. Not used.

3-4. TRAINING. The manufacturer’s representative shall provide training of Owner’s personnel as described in the Demonstration and Training specification.

End of Section

Section 26 32 13

ENGINE-GENERATOR

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of one (1) diesel fuel fueled engine-driven electric generator unit, designated as indicated on the Drawings. The engine-generator shall be located outdoors in its own weather proof sound attenuated enclosure as indicated on the Drawings.

The engine-generator Supplier shall be fully responsible to furnish a complete and coordinated skid mounted package system including engine-generator, generator line circuit breaker, generator controls, exhaust silencer, batteries and chargers, sub-base fuel storage tank, emergency shutdown control station, and all accessories required for a complete and operating system.

The engine-generator manufacturer shall coordinate with the supplier of the automatic transfer switch and accessories specified in the Bypass-Isolation Automatic Transfer Switch section. The ATS shall be supplied by others. All coordination requirements between the ATS and the engine-generator shall be provided.

1-2. GENERAL. Equipment furnished under this section shall be assembled in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Metrological and Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Coordination. All equipment specified in this section shall be furnished through a single engine-generator manufacturer who shall be responsible for the design, manufacture, coordination, and proper installation and operation of the entire system.

The engine-generator unit shall be a standard product of the manufacturer and shall be a packaged type unit, fully shop assembled, wired and tested, requiring no field assembly of critical moving parts.

Supplier shall verify that each component of the system is compatible with all other parts of the system; that all piping, materials, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

All necessary permits as required for the package system, inspections, and approval by the proper authorities in local jurisdiction of such work shall be provided by others with supplier's assistance.

Supplier shall properly coordinate the work between the suppliers of equipment specified herein to be used with or connected to the engine-generator, to ensure that all required provisions for mounting the accessories are included.

Equipment furnished under this section will be assembled by the Supplier and erected by others.

Design-Builder shall provide field services specified to assist in commission, testing and placing the unit in operation in full conformity with equipment manufacturer's specifications.

1-2.04. Governing Standards. Except where modified or supplemented by these specifications, all equipment and materials shall be designed and constructed in accordance with the latest applicable requirements of the standard specifications and codes of ANSI, ASTM, NEMA, IEEE, EEI, EGSA, HEI, ISO, NFPA, SAE, STI, UL, and other such regularly published and accepted standards as well as state and local codes.

1-2.05. Equipment Identification. All equipment, valves, devices, panels, and control equipment denoted by a symbol and an identifying number shall be provided with equipment identification tag or nameplate. Equipment identification shall be as indicated in the Equipment and Valve Identification Section.

1-2.06. Manufacturer's Nameplates. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a nameplate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable.

1-2.07. Power Supply. Site power supply provided will be a 480 volt, 60 Hz, three-phase, 50 amp feeder circuit to a transformer and panelboard provided by the manufacturer and installed in the engine-generator enclosure. Additional requirements for the panelboard are as indicated herein and in the Electrical Section.

The engine (starting and controls) will operate from batteries specified herein. When required, a control transformer shall be provided within the powerpanel for control supply.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, together with detailed specifications and data covering materials, drive unit, parts, devices and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Manufacturer, model, and type:
- Engine.
- Alternator.
- Enclosure.
- Battery charger and battery.
- Fuel oil cooler (if required by engine design).
- Silencer.
- Sub-base fuel storage tank.
- Surge Protection.

Engine output horsepower at rated capacity.
Fuel consumption at rated capacity.
Ratings at specified conditions:
- Engine (net horsepower).
- Engine (maximum performance horsepower bare engine).
- Engine-Generator kW at specified power factor.
- Volts.
- Amperes.

Overall dimensions and weight:
- Length.
- Width.
- Height.
- Net weight.

Wiring diagrams and schematics, including the engine control panel.
Generator line circuit breaker data (Elevation plan, weight, bill of material, component data sheets, breaker time-current characteristic curves).
Alternator insulation class and temperature ratings.
Alternator winding pitch.
Confirmation or test results showing compliance with specified motor starting and voltage dip requirements as well as unloading the specified loads.
Generator line circuit breaker rating.
Control panel layout, identifying location of all instrumentation being supplied.
Operation instructions.

Letter from the engine-generator manufacturer confirming that the unit will provide the specified minimum kW rating at the specified design conditions and time duration, including ambient air temperature rise from all equipment located inside the enclosure.

Confirmation that the starting batteries provide the specified number of start attempts for the specified time period.

Confirmation that the battery charger is sized to recharge the batteries for the specified condition and time period.

Maximum output short circuit kvA available.

Exhaust gas emission data, maximum values at loads of 1/2, 3/4, and full:

- Carbon Monoxide (CO), lb/hr
- Nitrogen Oxides (NO_x), lb/hr
- Particulate Matter (PM), lb/hr
- Sulfur Dioxide (SO_2), lb/hr
- Unburned Hydrocarbons (UHC_s), lb/hr
- Temperature, °F
- Flow, acfm

Equipment skid Drawing including material list.

Confirmation that the exhaust through the exhaust silencer does not exceed the specified maximum pressure loss at the specified output capacity of the unit.

Letter from the engine-generator manufacturer confirming that the enclosure is suitable for the specified wind velocity and is designed as specified for rain penetration when the unit is operating.

Name, address, and phone number of manufacturer's repair facility.

Name, address, and phone number of who will troubleshoot electrical problems.

Color chart showing available options for the enclosure color. The color of the enclosure shall be as directed by Owner during shop Drawing review.

Drawing to show location of grounding system for electrical grounding of the engine-generator package.

Drawings showing engine-generator inside the enclosure that shows location of all enclosure mounted and engine-generator mounted equipment.

Drawings to indicate maintenance access clearances for electrical and mechanical equipment.

Drawing to show location of all enclosures bracing and location of doors, access platforms, stairs, sub-base tank fill access door and removable panels.

Drawing to show location of all enclosures bracing and location of doors, access platforms, stairs, sub-base tank fill access door and removable panels.

Identification of all field connections for electrical, control, or other service and associated connection requirements to be performed.

Detailed procedures and instrument calibration reports for all items associated with the shop and field testing activities.

Letter from the engine-generator manufacturer confirming that the unit is in full compliance with Federal EPA, State, San Luis Obispo County Air Pollution Control District (SLOAPCD), and local air emission requirements.

Confirmation that the engine-generator unit, including the enclosure, louvered openings, and exhaust system will limit the noise not to exceed the specified decibel reading at the specified distance from any point from the enclosure when operating at the specified capacity.

Provide recommendation for mounting the engine-generator for the specified seismic parameters.

Anchor Bolts.

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

1-5. SPARE PARTS. A list of recommended spare parts shall be provided by the manufacturer in accordance with the general Terms and Conditions.

All spare parts shall be provided in waterproof packages suitable for export service, labeled with its description and part numbers. Each item or set of parts expected to be installed at one time shall be in an individual package. The spare parts shall be stored as directed.

1-5.01. Spare Keys. Three (3) sets of identical keys for locks on the enclosure and all cabinets shall be provided.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The engine-generator unit shall be designed to operate under the Seismic wind and snow design requirements including importance factor, ambient air temperature range and site elevation as listed in the Meteorological and Seismic Design Criteria section.

The engine-generator unit will be used as a power unit for selected electrical loads for standby operation when the utility supplied power fails.

The engine-generator shall automatically start, and connect to the plant's electrical system via a remote signal from the plant control system or when initiated from the automatic transfer switch controls.

Fuel for the engine-generator unit will be furnished from a sub-base fuel tank. The engine-generator Supplier shall provide the correct amount and grade of crankcase oil, coolant, and other fluids (except fuel) necessary for initial testing and operation.

2-1.01. Engine Mounting. The engine-generator shall be attached to an associated skid suitable for mounting on top of the sub-base fuel storage tank that is anchored to a reinforced concrete base. The skid shall be constructed of heavy duty steel. Designed and built to resist deflection and to maintain alignment during lifting and operation during any range of operation. Mounting holes in the structural skid shall be suitable sized to accommodate thermal expansion of the unit and shall be drilled prior to setting the unit.

Unless otherwise recommended by the manufacturer, the engine-generator sub-base fuel storage tank package shall be attached to the reinforced concrete base using suitable number of hold down lugs and anchor bolts. Use of clamping devices to secure the sub-base fuel storage tank will not be acceptable. Anchor bolts may be pre-cast in the reinforced concrete base or holes drilled into the concrete base at the required location and the anchor bolts secured with epoxy resin. Unless otherwise recommended by the manufacturer, the nuts for the anchor bolts shall be hand tighten.

2-1.02. Anchor Bolts. All field assembly bolts, anchor bolts, nuts, and washers shall be stainless steel as specified in the Anchorage in Concrete and Masonry Section. All anchor bolts, nuts, and washers required for installation shall be provided by the Supplier.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The engine-generator unit shall be designed for the operating conditions and requirements as follows:

Designation	As indicated on Drawings	
Generator		
Minimum power rating capacity with accessories, for generator voltage output and service conditions specified herein.	1,250	kW
Output frequency.	60	Hz
Output voltage.	480	VAC
Output power factor.	0.8	

Output phase and configuration.	Three phase, 4 wire, solid grounded wye configuration	
Engine		
Fuel supply.	No. 2 ultra-low sulfur diesel	
Maximum speed.	1,800	rpm
Minimum piston displacement.	TBD	in^3
Black start required.	Yes	
Maximum outside length of the engine-generator including air intake plenums and radiator discharge plenums but not including access platforms or stairs.	TBD	in
Maximum outside width of the engine-generator package including air intake plenums but not including access platforms or stairs.	TBD	in

The engine-generator shall be designed to be operated during a power outage for a maximum of 24 continuous hours and a maximum of 100 hours per year for maintenance and testing. Unit shall be certified for stationary emergency use in accordance with NSPS.

Engine-generators submitted with ratings in excess of current published data will not be acceptable.

The entire engine-generator package system shall be electrically grounded with provisions to connect to a grounding system installed by others.

Engine performance, cooling, and all accessories to account for the outside ambient air temperature increase from heat rejected from all equipment located inside the enclosure.

The engine-generator unit furnished shall be of a design that can be accommodated in the space as indicated on the Drawings. Maximum outside dimensions of the engine-generator enclosure including any air intake or discharge plenums shall be as specified and as noted on the Drawings.

The engine-generator shall meet all local air emission requirements including those of SLOAPCD and at a minimum, meet the required Environmental Protection Agency New Source Performance Standard emission regulations. The unit shall be certified at the factory prior to shipping.

The engine-generator Supplier shall coordinate with the local air quality management authority to ensure the equipment meets all current local air emission requirements. The engine-generator Supplier shall guarantee the equipment supplied meets all local and SLOAPCD air emissions requirements in place at the time of startup.

Field testing of actual emissions will be required per Section 3-3 to verify compliance with the emission requirements.

The engine-generator shall at minimum meet the specified maximum allowable noise emission specified herein and any local noise emission requirements, whichever is more stringent.

2-2.01. Performance Tables.

2-2.01.01. Load Requirements. The engine-generator shall satisfactorily start the following loads in the listed order, while meeting the specified voltage dip:

Step	Load Description	Load	Maximum Voltage Dip (%)	Comments
1	Lighting Transformers, Power Panels, HVAC, and RO Feed Tanks Water Pump 3	356 kW	20	Across the Line Start
2	Headworks, MBR, and RO Power Panels	132 kW	20	Across the Line Start
3	Headworks Equipment and MBR Compressors	13.4 kW	10	Across the Line Start
4	MBR and Product Water Pumps	201 kW	10	VFD
5	MBR and BNR Blowers and BNR Pumps	164 kW	10	VFD
6	Sanitary Lift Station Equipment	18.6 kW	10	Across the Line Start
7	Headworks Equipment and Odor Control	18.6 kW	10	Across the Line Start
8	RO Pumps, MBR Mixers, and Sludge Tank Mixers	23.5 kW	10	VFD

2-2.01.02. Unloading Requirements. The engine-generator shall satisfactorily unload the loads indicated above in any order one at a time while not exceeding overspeed, frequency deviation, and voltage deviation.

2-3. ACCEPTABLE MANUFACTURERS. The engine-generator shall be a current production model. The engine-generator shall be manufactured by the Supplier Caterpillar, Cummins, MTU or Kohler or equal as approved by Design Builder.

The complete engine-generator package shall be assembled prior to shipping, to the fullest extent possible, by the engine-generator manufacturer or their representative.

The manufacturer of the engine-generator unit shall have a full-time factory trained technical staff and an equipped twenty-four (24) hour service facility having all personnel and all equipment required to maintain, repair, or overhaul the engine-generator unit and associated equipment.

2-4. ENGINE-GENERATOR UNIT.

2-4.01. Engine. The engine shall be reciprocating 4-stroke cycle compression ignition type and shall be equipped with the following:

Electronic governor for isochronous regulation of engine speed from no load to full load alternator output.

Dry type air cleaner with replaceable elements.

2-4.02. Alternator. The engine-generator alternator shall be a 4 pole, revolving field design with temperature compensated solid state voltage regulator, brushless rotating rectifier exciter system, and drip-proof construction with amortisseur windings. The alternator shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semi-flexible driving flange to ensure permanent alignment.

Frequency regulation shall be isochronous ±0.15 Hz from no load to rated load. Voltage regulation shall be within ±2 percent of rated voltage, steady state, from no load to full load. The momentary voltage drop shall not exceed the specified percent without starter coils dropping out or stalling the engine at any time when applying or starting the specified loads. Recovery to stable operation shall occur within 2 seconds.

The alternator shall have Class F insulation as defined by NEMA MG1-1.65 and temperature rise shall be within NEMA MG1-22.40 definition at rated condition.

An alternator winding heater shall be furnished as an integral part of the engine-generator unit. The alternator winding heater control system shall include an interlock with the engine-generator unit so that the heaters are de-energized at all times that the generator field is energized. The Supplier shall provide all internal alternator winding heater wiring and fused branch circuit protection.

The winding pitch shall be 2/3 pitch.

2-4.02.01. Surge Protection. The engine-generator shall be provided with a voltage surge protection system installed in the generator terminal box that is located inside the enclosure.

The surge protection system shall include a surge capacitor and surge arrestor. All cable required to connect the surge protection system to the generator terminals shall be furnished and installed under this section.

2-4.03. Fuel System. The engine-generator unit shall be furnished with a complete fuel system including engine-driven fuel pump, double wall sub-base fuel storage tank, engine supply and return lines, and all accessories required for proper operation. All items shall be suitable for the specified fuel and located inside the enclosure and serviceable from inside the enclosure. The engine driven fuel pump shall transfer the fuel from the sub-base fuel storage tank to the engine-generator and maintain prime regardless of fuel level in the sub-base fuel storage tank.

The fuel system and all fuel piping shall be suitable for the specified fuel and shall meet all NFPA, State, and local requirements.

2-4.03.01. Sub-Base Fuel Storage Tank. The sub-base fuel storage tank shall be a rectangular sub-base type double wall and shall be located below the engine-generator and shall be constructed to permit access to the electrical stub-up area. The primary tank and secondary tank shall meet all EPA, State, and local requirements, be vented, and shall normally be used to store diesel fuel at atmospheric pressure. The primary internal steel tank and the secondary outer steel tank shall each be of welded construction throughout and each shall be UL 142 listed and labeled.

The sub-base fuel storage tank shall have a minimum usable capacity to provide for storage for 24 hours of continuous operation of the engine-generator when operating at 100 percent capacity but not less than 2,500 gallons.

The secondary tank shall be closed top, encircle the tank, prevent the containment area from being contaminated, and be sized to contain minimum 110 percent of the primary tank's capacity. Closed top dike tanks are not acceptable. All connections required for field-testing the secondary tank shall be furnished.

The fuel storage tank shall be provided with the following:

Primary tank vent cap.

Secondary tank vent cap.

Primary tank emergency vent.

Secondary tank emergency vent.

Level gauge that is capable of measuring the fuel level without engine running and is viewable from the manual fill connection.

Fill spill containment box.

Automatic shutoff valve on the fill line.

Check valve in the fill line.

Cap for pump out connection.

Quick Fill Coupling.

2-4.03.02. Fuel Tank Connections. All connection for the sub-base fuel storage tank shall be located inside the enclosure and on top of the tank and shall include the following:

Engine fuel supply.

Engine fuel return.

Primary tank vent.

Secondary tank vent.

Primary tank emergency vent.

Secondary tank emergency vent.

Secondary tank testing port with cap.

Manual fill with dry type quick fill coupling.

Level gauge with transmitter for remote level indication on the engine control panel and near fill door.

Low level switch.

Leak detection.

Minimum 2-inch tank manual pump out with cap. Pump out line to extend to within 2 inches of the bottom of the tank.

Three, 2-inch diameter spare primary tank connections with caps.

Minimum 3-inch diameter spare primary tank connection with blind flange.

High level switch with externally mounted alarm horn and silence button located near the fill connection.

High-High level switch if required for automatic shutoff of the fuel fill.

2-4.03.03. Fuel Tank Instrumentation. The fuel storage tank shall have instrumentation suitable for the geometric configuration of the tank that includes, but not limited to the following:

Level indication readout on the engine control panel with contacts for transmission of a remote 4-20mA signal for remote level indication. Power, if required, shall be pre-wired and fed from the engine-generator local control panel.

Level switch with electrically isolated dry contacts for remote leak detection of the primary tank and shall be provided with feedback to the engine-generator control panel.

Low level switch with electrically isolated dry contacts for remote low level annunciation on the engine control panel. The Low Fuel alarm shall be set to annunciate when 25 percent or less of the tank's capacity is remaining in the tank above the engine supply connection.

High level switch for annunciating audible alarm at 90 percent capacity in the fuel storage tank. Audible alarm horn with silence button shall be located near the fill connection.

High-high level switch with electrically isolated contacts to shut off an electrically operated valve if used in the full line at 95 percent capacity in the fuel storage tank.

One common, isolated, dry contact to close for any fuel system alarm.

The fuel system controls shall be pre-wired and powered from the panelboard.

2-4.03.04. Fuel Tank Fill Station. Tank fill connection, pump out, level gauge, and overfill alarm shall be accessible at ground level through a lockable access door in the enclosure. If located outside of the enclosure the spill containment box shall be provided with a lockable hinged lid. A fill spill containment box shall be provided for containment of spillage during tank fill or tank pump out.

The fill system including piping, fittings and the automatic shutoff valve, shall be suitable for a pump flow from a fill truck. The fill connection shall include a dry type quick disconnect coupling sized to accommodate the local fuel distributor.

A ground stud for the fuel supply truck shall be supplied near the fill connection.

Tank fuel fill location shall be located as specified herein and as indicated on the Drawings.

2-4.03.05. Fuel Tank Overfill Protection System. A comprehensive fuel tank overfill protection system shall be provided as a described herein. All devices and components shall be pre-wired from the system control panel with feedback to the engine-generator control panel as indicated.

Set at 90 percent capacity, the High Fuel alarm shall provide an audible alarm near the fill connection to alert the fill operator to prevent overfill of the fuel storage tank. A silence push button shall be provided to silence the alarm horn, automatically resetting when the fuel tank level has dropped below the high level conditions.

The fuel storage tank remote fill line shall include a suitable means for automatic shutoff of the fill line when 95 percent of the tank capacity has been reached. If electric operated valve is used, it shall be AC powered and be interlocked with the High-High level switch. The fill system including piping, fitting, and the automatic shut off valve shall be suitable for a pumped flow from a fill truck.

2-4.03.06. Fuel Tank Vent System. A suitable sized vent connection and vent cover shall be provided for the primary tank and secondary tank vent. Each vent cover shall be installed outside the enclosure. The cover shall have an aluminum body, screen over the outlet, and shall prevent rain from entering the vent line.

Suitable sized emergency vent connections for the primary and secondary tank and emergency vents shall be provided for the fuel storage tank. Each emergency relief vent shall be installed outside the enclosure and shall be designed as required to relieve excessive internal pressure caused by fire exposure.

Each vent line and each emergency relief vent line shall be routed up on the inside of the enclosure and shall terminate just above the enclosure. Suitable support shall be provided as required to prevent vibration and damage from the specified wind velocity in the Meteorological and Seismic Design Criteria section.

2-4.03.07. Fuel Line Flexible Connectors. Stainless steel flexible connectors shall be provided for the diesel fuel supply and return lines and at a minimum shall be located at each connection to the engine, upstream of the combination fuel filter/separator, and in the return line to the sub-base fuel tank. The stainless steel flexible connectors shall be U.S. Hose “Model 401M” or equal.

2-4.03.08. Fuel Filter. A combination fuel filter/separator shall be located inside the enclosure and installed on the fuel supply line between the sub-base fuel storage tank and the engine driven fuel pump, upstream from the flexible connectors. The combination fuel filter/separator shall be a manifold unit with shutoff valves and shall permit servicing the filter/separator without needing shutdown. This shall permit valving off the filter/separator and bypassing the fuel

to the other filter/separator. Filter separator shall be manufactured by Racor or equal.

2-4.03.09. Fuel Coolers. Fuel oil coolers shall be provided if the engine fuel system absorbs heat from the unit injectors and surrounding jacket water. The fuel cooler shall be a radiator mounted, air cooled that uses the air flow from the radiator for cooling air flow. To prevent overheating of the fuel in the sub-base fuel storage tank, the fuel oil cooler shall be adequately sized to cool the return fuel from the engine to the required fuel inlet temperature.

2-4.04. Exhaust System. The engine-generator unit shall be furnished with a complete exhaust system including an exhaust silencer, stainless steel bellows expansion joints, and accessories required for a complete operating system that will comply with SLOAPCD requirements.

Exhaust piping shall be suitable for the application with buttwelded fittings.

The exhaust silencer shall be all welded construction. The exhaust silencer shall be furnished with suitable bracket supports for horizontal mounting either on top of or inside the enclosure. The silencer shall be sized so that the back pressure at rated capacity of the engine does not exceed one half the manufacturer's maximum allowable back pressure. The exhaust from the engine shall enter either the bottom or side of the silencer. Silencer shall be Maxim, Nelson or equal.

A silencer shall be provided in order to meet the overall engine-generator unit noise emissions requirements specified herein.

The exhaust silencer, if located inside the enclosure, and all exhaust piping inside the enclosure shall be thermally and acoustically insulated with removable insulation.

The exhaust shall discharge vertically at the silencer outlet. If the exhaust termination point is less than ten feet away from any portion of the Electrical Building, exhaust extension piping shall be provided such that the termination point shall be two feet above any portion of the building within ten feet of the exhaust piping. Suitable support shall be provided for the exhaust pipe as required to prevent vibration and damage from the specified wind velocity in the Meteorological and Seismic Design Criteria section. A rain cap shall be provided to prevent rain from entering the exhaust pipe. The rain cap shall open from exhaust pressure from the engine and shall close when exhaust flow stops. The cap shall be counter-balancing with vertical discharge.

Exhaust emission test ports shall be provided in the exhaust piping after the silencer. Ports shall be threaded and shall be provided with threaded plugs or caps.

2-4.05. Starting System and Control Power. The engine-generator unit shall be furnished with a complete electric motor start system including starting motors, battery pack with rack, cables, and battery charger.

The batteries shall be of the high-rate, lead acid type and have a 24 volt output. The batteries shall be sized for five 10 second cranks with battery and engine oil temperature of 30°F, and a battery end voltage of 70 percent of system voltage.

The battery charger shall float-charge the battery pack and shall be solid state, full wave bridge rectified type, utilizing silicon controlled rectifiers for power control.

The battery charger shall be suitable for the lead acid battery pack. The charger shall have a minimum DC output of 20 amperes. The battery charger shall be provided with a NEMA 2 corrosion resistant enclosure and shall be provided with the following: on/off switch, DC ammeter, DC voltmeter, AC input and DC output circuit breakers or fuses, floating voltage equalization, equalizing timer, and relays with form c contacts for remote annunciation of loss of AC power, low battery voltage, and high battery voltage.

The batteries, battery rack, and battery charger shall be located inside the engine-generator enclosure. The battery rack frame shall be constructed of corrosion resistant material.

The engine-generator shall automatically supply power to the remote bus that powers the battery charger when it is operating and when utility power is not available.

An electric pad type heater shall be provided with the batteries. The pad heater shall be thermostatically controlled and be sized to maintain the batteries at 50°F with a winter ambient temperature as specified. The strip heaters shall be powered from the panelboard specified herein and shall be wired by the engine-generator supplier.

2-4.06. Cooling System. The engine-generator unit shall be cooled with unit-mounted radiator cooling system complete with radiator, expansion tank, water pump, belt-driven fan, fan guard, thermostatic temperature control, high-water temperature cutout, electric jacket water heater and all accessories required for proper operation. The radiator shall be sized with sufficient capacity for cooling of the engine and all other accessories required for proper operation including the ambient air temperature rise inside the enclosure. The fan shall draw air over the engine and discharge through the radiator.

The cooling system shall be filled with a permanent antifreeze mixture of the ethylene glycol type with rust inhibitor suitable for the service conditions specified herein.

The electric jacket water heater shall be furnished to maintain jacket water at 90°F with a winter ambient temperature as specified in the Meteorological and Seismic Design Criteria Section. The jacket water heater shall be thermostatically controlled.

The jacket water heater shall be powered from the panelboard supplied in this section and shall be wired by the engine-generator Supplier.

2-4.07. Engine-Generator Enclosure. The engine-generator unit, including control panel, battery rack, battery charger, panelboard, sub-base fuel storage tank, and other ancillary equipment, shall be housed in a weatherproof and sound Attenuated enclosure. The enclosure shall be shop mounted on the engine-generator skid by the Supplier.

The enclosure shall be designed to withstand the specified conditions as defined in the Meteorological and Seismic Design Criteria Section.

2-4.07.01. Enclosure Fabrication. The enclosure shall consist of two side walls, two end walls, and roof. The roof shall be braced as necessary to support the exhaust system. All bracing and reinforcing members shall be integral to the enclosure.

Roof penetrations for the installation of the silencer shall be gasketed to prevent the entrance of rain.

The enclosure shall be constructed of either steel or aluminum. Steel enclosures shall be constructed with a support frame of not less than 14 gage steel and roof panels of 16 gage. Aluminum enclosures shall be formed sheet aluminum construction, made of modular panels and louvers. Post, rails, channels, and roof bows shall be 6061-T6 extruded aluminum. The panels shall be 0.04 inch thick aluminum.

Access service platforms along each long side shall be provided for access to the engine-generator if the sub-base fuel storage tank height exceeds twenty four (24) inches. Platforms shall be as tall as the sub-base tank.

Access platforms and stairs shall be of galvanized steel and aluminum construction. The access platforms shall be four (4) feet wide and shall be located on each side of the enclosure with individual stairs to each platform. Suitable brackets shall be welded to the enclosure at the factory for field-bolting the access platforms or stairs onto the brackets on the enclosure. Stairs and handrails shall not prevent the enclosure doors from opening fully.

The service platforms or stairs shall be OSHA compliant and shall be provided by the engine-generator manufacturer.

The enclosure shall be rain proof type as defined by UL2200 and shall prevent the wetting of live parts when the unit is operating. If required to meet the rain penetration requirements, “rain resistant” louvers, vertical air turning plenums or a combination of the two shall be provided.

The enclosure walls shall be reinforced to support the plenums. Plenums shall utilize bracing as required to prevent vibration and damage from the specified wind velocity in the Meteorological and Seismic Design Criteria section and shall be bolted to the enclosure walls to permit removal and reinstallation.

A minimum of four separate doors, two per side, shall be provided and located for easy maintenance access to the engine-generator, controls, and accessories. Doors shall be lockable with stainless hardware. Maximum width of each individual door shall not exceed three (3) feet.

The entire enclosure, except for the louvered opening, shall be provided with noise suppression insulation.

The enclosure shall be provided to meet the overall engine-generator unit noise emission requirements as specified in Section 2-4.13. Field sound level tests shall be performed on the unit as specified in Section 3-3.02.

The sub-base fuel storage tank fill connection locations shall be accessible through its own access door from the ground level located on the Northern side and radiator end of the enclosure as indicated on the Drawings.

If required, access door shall be provided in front of the auxiliary power terminal box, control panel, and panelboard to permit access and working space from outside the enclosure when the door is open.

Engine oil and coolant drains shall be piped to the outside of the enclosure with lockable shutoff valves and caps.

All enclosure penetrations shall be gasketed or sealed to prevent the entry of rodents.

The enclosure shall be cleaned and painted as specified herein.

2-4.07.02. Enclosure Ventilation. The enclosure shall be provided with intake and exhaust louvers with dampers to open on engine start. Louvers and dampers shall be sized for the cooling air requirements. Louvers shall be AC powered closed and spring open on unit start. The louvers shall be screened from the inside to prevent the entry of birds. The louvers shall be pre-wired to the panelboard specified in this section.

The enclosure shall be provided with vertical air turning plenums for cooling air intake. The air inlet turning plenum shall be located on the end of the enclosure opposite the radiator discharge.

The enclosure shall be provided with vertical air tuning plenums for radiator discharge air. The radiator discharge plenum shall direct the air and mechanical noise upwards away from the unit, and shall be supplied with a bottom sump area, with a one inch drain and shutoff valve to remove any moisture.

2-4.07.03. Electrical. The engine-generator enclosure shall be provided with interior AC/DC operated maintenance lights, controlled with a 1 hour, wind-up timer switch shall also be provided. A duplex receptacle rated 20 amp, 125 volts with a weatherproof enclosure shall be mounted inside and near the middle of the enclosure.

The enclosure shall be pre-wired, requiring only external connection to the panelboard.

2-4.08. Crankcase Vent Blow-By Absorber. Suitable crankcase breather system shall be provided by the engine-generator manufacturer to remove oil mist from the crankcase emission prior to induction into the air intake system. The system provided shall meet the applicable level mission requirements.

2-4.09. Control Panel. The engine-generator unit shall be provided with a unit mounted control panel that shall be accessible from outside the enclosure when the enclosure doors are open. The panel shall be provided with vibration isolators to prevent damage to the instruments from engine-generator vibration.

Adequate clearance shall be provided between the panel and engine to allow engine maintenance with removing the control panel.

The control panel shall be automatic and safety type and shall, at a minimum, include all items required by NFPA 110, Level 1, and in addition the following instrumentation and controls:

Tachometer.

Non-resettable hour meter.

AC voltmeter, AC ammeter, voltmeter/ammeter selector switch with “OFF” position.

Two normally open dry contacts which close when the engine is running and open when it is stopped.

Dry contact that closes for remote common alarm.

Dry contact that closes when the control selector switch is in “AUTO” mode.

Three-position selector switch with “RUN-OFF-AUTO”.

Indicating lights with common alarm for the following:

Sub-base tank low fuel level.

Sub-base tank leak detection.

Sub-base tank continuous reading level.

Dry contact for common alarm.

Contacts for a remote two position maintain contact emergency shutdown switch.

The control panel shall be provided with a three-position selector switch with the following positions: “RUN-OFF-AUTO”. In the “RUN” position, the engine starting sequence shall be initiated providing local control for maintenance, in the “AUTO” position, the engine-generator will be remotely started and stopped by a run contact from the remote statin located at the engine-generator switchgear. Isolated contacts for when the unit is in the “OFF” position shall be provided for remote indication.

2-4.09.01. Emergency Shutdown Control Station. A remotely located emergency shutdown control station shall be furnished under this section and connected to the engine-generator control panel. The control station when activated shall shutdown the engine-generator regardless of the position of the “RUN-OFF-AUTO” selector switch. The control station shall be located as indicated on the Drawings. Control wiring between the control station and the engine-generator control panel shall be furnished by the installing Supplier.

2-4.10. Panelboard. The engine-generator unit shall have an auxiliary panelboard center mounted inside the enclosure and isolated from engine-generator vibration. The power center panelboard shall be pre-wired to all engine-generator accessories as needed. The panelboard shall supply power including but not limited to the following:

Engine-generator starting system battery charger.

Enclosure lights and receptacles.

Fuel system.

Enclosure intake and exhaust louvers/dampers.

Engine jacket water heater.

Alternator winding heater.

Battery pad heater for starting batteries.

The panelboard shall have an integral surge protection device as specified in the Electrical section. All electrical equipment and materials shall meet the applicable requirements of the Electrical section.

2-4.11. Generator Line and Generator Component Overcurrent Protection. A generator line circuit breaker rated for the generator output voltage, having the trip rating indicated on the Drawings, shall be provided on the output terminals. The line circuit breaker shall be pre-wired to the generator output terminals, and shall be provided within the generator enclosure.

Overcurrent protection devices shall be provided as needed by the system design to protect generator rotor and excitation system components.

2-4.12. Limiting Dimensions. The engine-generator unit furnished shall be of a design that can be accommodated in the space available as specified herein.

2-4.13. Noise Emissions. The engine-generator unit, including the enclosure, louvered openings, and exhaust system, shall be designed to limit the noise emissions to not exceed the A-weighted sound pressure level of 70 dB(A) at 50 feet from any point of the engine-generator unit when operating at the specified capacity, and when measured in accordance with industry standards such as but not limited to ANSI S12.18, ASME PTC 36, ISO 8528-10.

2-5. SHOP PAINTING.

2-5.01. Engine-Generator. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, engine, alternator, enclosure, piping, and valves shall be shop primed and finish painted prior to shipment to the site.

Stainless steel, nonferrous, and nonmetallic surfaces shall not be painted.

2-5.02. Enclosure and Sub-Base Tank. The enclosure shall be thoroughly cleaned after assembly, etched, and shop painted, both interior and exterior surfaces. The enclosure and sub-base tank shall be painted according to the manufacturer's standard practices with the interior receiving at least one coat ANSI gray and the exterior powder coated with UV inhibitor. Paint colors shall be as selected by the Owner.

2-6. SHOP TESTS.

2-6.01. Engine-Generator Shop Test. The manufacturer shall shop test the engine-generator set with its control panel and unit mounted radiator to demonstrate that the equipment conforms to specified requirements for load capacity using a load bank at the specified frequency, voltage, phase, and power factor.

All items included on the control panel shall be assembled, wired, and tested in the manufacturer's shop.

At a minimum the tests shall consist of repeated starts and stops, operation under a load bank at specified capacity, frequency, voltage, phase, and power factor for a minimum of 1 continuous hour, and tests to demonstrate that each safety shutdown device is working properly.

Certified copies of the shop test results shall be submitted to the Design-Builder prior to shipping the unit.

2-6.02. Sub-Base Fuel Storage Tank Shop Test. The sub-base fuel storage tank manufacturer shall shop test the sub-base fuel storage tank using the tank manufacturer's procedures.

2-7. OPERATION INSTRUCTION. Step-by-step instructions shall be furnished by the engine manufacturer for the unit. The instructions shall include, but not be limited to, the following procedures or information:

Startup of the unit.

Normal shutdown of the unit.

Emergency shutdown of the unit.

Normal operation of the unit, typical temperatures, pressures, speed, etc., for gauges and instruments which are displayed on the panel.

The operation instructions shall be submitted for review in accordance with the Submittals Procedures section. When the review is complete, the instruction sheets shall be printed on heavy paper or cardboard stock and laminated with clear plastic. Two copies of the laminated instructions shall be furnished with the unit. The instructions specified here are in addition to the operation and maintenance manuals required by the Submittals Procedures section.

2-8. PERMITS.

2-8.01. Air Emission Permit. Supplier shall provide all pertinent information to the Design-Builder who shall be responsible for preparing and submitting air emissions permit application on behalf of the Owner to the local air quality

authority for the engine-generator being supplied based on the maximum number of operating hours and the guaranteed emissions.

PART 3 - EXECUTION

3-1. INSTALLATION. The engine-generator shall be installed in accordance with the Equipment Installation section and as specified herein.

The exposed finish shall be inspected after delivery including pipe connections, fittings, valves, and specialties. Burrs, dirt, and construction debris shall be removed and any damaged finishes, including chips, scratches, and abrasions shall be repaired.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Commissioning section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of the Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3-3. FIELD TESTING. Manufacturer's field services shall be provided for field testing. All costs for these services shall be included in the Contract Price.

3-3.01. Engine-Generator Performance Test. The unit shall be mechanically checked for proper operation. Each alarm and safety shutdown shall be checked by artificially simulating an alarm condition. Defective equipment and controls disclosed by the tests shall be replaced or corrected, and the packages placed in satisfactory operating condition.

The engine-generator unit shall be tested to demonstrate that the equipment conforms to specified requirements for load capacity, and starting duty.

The complete system (engine, generator, fuel system, exhaust system, starting system and control panel) shall be field tested together by the manufacturer as a complete system to assure compatibility.

The tests shall consist of repeated starts and stops, operation using a load bank at the specified power rating and power factor for the duration indicated below.

Before each of the following tests, the engine shall be brought to steady state conditions as determined by the instrument readings:

- Four (4) continuous hours at the specified power rating and power factor within normal operating conditions of the unit without any alarm conditions.
- Four (4) starts of the specified electrical loads in the order listed followed by 30 minutes of continuous operation per start all within normal operating conditions of the unit without any alarm conditions.
- Demonstration that each safety shutdown device is working properly.

Supplier shall furnish the lubricants, load bank, and the fuel for the tests.

At the option of the Design-Builder, an independent laboratory will be provided by others for the exhaust gas sampling and analysis during the 4 hour load test of the engine. The laboratory analysis will be used for verification the unit meets the guaranteed emissions.

Any retesting or modifications to the equipment to meet the above requirements and emission guarantees shall be approved by the Design-Builder. Supplier shall be responsible for all costs for modifications and retesting, including the independent laboratory for air emission testing.

The following items shall be measured, recorded at 15 minute intervals, and submitted in a field test report:

Outdoor ambient temperature.

kW output.

Engine speed, rpm.

Engine jacket water temperature.

Engine oil pressure.

Start time.

Completion time.

Test reports shall verify that the specified tests have been performed and shall state results. Test results shall be submitted as required in the Submittals Procedures section.

3-3.02. Engine-Generator Field Sound Level Test. At the option of the Design-Builder, the installed equipment shall be tested for noise during one of the 30 minute performance tests. The measured engine-generator sound levels shall not exceed the sound level specified herein.

Compliance with the noise emissions requirement shall be determined in accordance with industry standards including ASME PTC-36. Compliance shall be based on not exceeding the allowable sound level including background sound level correction per section 4-2.6 ASME PTC-36 and excluding any correction for measurement uncertainties.

Any retesting or modifications to the equipment or enclosure to meet the above requirements shall be approved by the Design-Builder. Supplier shall be responsible for all costs of modifications and retesting.

Test reports shall verify that the specified tests have been performed and shall state results. Test results shall be submitted as required in the Submittals Procedures section.

3-3.03. Fuel Storage Tank Tightness Testing. After shipment to the Site, but prior to installation, the inner primary tank and secondary outer tank shall be pressure tested. While maintaining pressure required by the tank manufacturer for the primary and secondary tank, the inner primary tank and the outer secondary tank shall be checked for leaks using an air gauge. During testing, connections may be plugged but shall not be blocked or plugged on the inside. If there are leaks or indications of leaks, the supplier shall replace the tank with a new tank and shall be tested after shipment to the jobsite.

Tightness testing at the site is not required if the tank is shipped from the factory with a vacuum drawn on the interstitial space and is maintained through completion of installation. This shall be documented throughout the fabrication, shipping and installation process and provided to the Design-Builder.

3-4. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer’s expense.

3-5. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the

equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-5.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-5.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

3-6. INITIAL TANK FILL. Upon satisfactory completion of all work, the sub-base fuel tank shall be filled by others with the specified fuel.

End of Section

Section 26 36 26

AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1-1. SCOPE. This section covers both indoor and outdoor automatic transfer switches which shall be furnished, and tested as specified and as indicated on the Drawings.

Automatic transfer switch equipment shall meet the design conditions and features.

Automatic transfer switch equipment shall be designated and located as follows:

Tag number(s).	As per Electrical One-line 80-E-701
Transfer switch designation(s).	As per Electrical One-line 80-E-701
Location of transfer switch(es).	As per electrical drawing

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected , and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If stipulations in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Design-Builder.

1-2.04. Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

1-2.05. Governing Standards. The equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

UL 1008;
NFPA 110;

The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

1-2.06. Nameplates. Nameplates with designation of each control or indicating device shall be mounted on the switch enclosure. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/4 inch [19 mm] high letters for section identity and 1/8 inch [3 mm] letters for other information. The engraving shall extend through the black exterior lamination to the white center.

Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

1-2.07. System Characteristics. The equipment will be connected to a power system with characteristics as specified below:

Voltage, phase	480, 3-phase V
Frequency	60 Hz
Number of conductors	4-wire

1-3. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the transfer switch, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Drawings showing front and side views, plan, and weight.
Rating and specifications.
Circuit breaker time-current characteristic curves, if applicable.
Single-line, control schematic, and wiring connection diagrams.
Operation and maintenance and manuals including a list of spare parts.
Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE MANUALS. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in

addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and Storage shall be in accordance with the manufacturer recommendations and this Section.

1-6. SPARE PARTS. Standard spare parts shall be provided.

1-7. ARC FLASH HAZARD LABELS. Switchboards shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E.
Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

Additional information shall be provided on the labels as per the Arc Flash Hazard Analysis performed by the Supplier.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS.

The automatic transfer switch shall be manufactured by Automatic Switch Co. (ASCO), GE Zenith Controls, or Russelectric Inc., without exception.

2-2. CONSTRUCTION FEATURES.

2-2.01. Enclosure. The enclosure for the transfer switch shall be as follows:

Type of mounting	Freestanding
Enclosure rating	Indoor NEMA Type 1

Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

2-2.02. Rating. Automatic transfer switches shall be rated for continuous duty in both normal and emergency positions. The switches shall have the number of poles as specified below, and shall be double-throw. Ampere ratings, and 3-cycle closing and withstand ratings shall be as specified below.

Number of poles	4-pole
Ampere rating and 3-cycle closing and withstand rating	As indicated on the Drawings

Switches shall be service entrance rated.

2-2.03. Space Heaters. Not used.

2-3. PERFORMANCE AND DESIGN REQUIREMENTS.

2-3.01. Equipment Description. The automatic transfer switches shall transfer electric loads from the normal source of electric power to an emergency source of power as indicated on the Drawings. The transfer switches shall automatically transfer the electrical load circuits upon an interruption or a decrease in the voltage of the normal source of power and shall transfer the loads back to the normal source when it becomes available. The transfer switches shall be furnished without integral overcurrent protection. The switches shall be electrically operated but mechanically held in both the normal and emergency positions. The operating mechanism shall be momentarily energized from the source to which the load is being transferred. All main and arcing contacts and control elements shall be removable from the front of the switches without removing the switch from the enclosure and without removing the power cables. The automatic transfer switches shall be so designed that the load circuits cannot be connected to more than one source of power at a time. The automatic transfer switches shall be magnetic contactor type.

2-3.01.01. Automatic Transfer Switch. The automatic transfer switch shall be an electrically operated double throw switch. Main contacts shall be silver composition. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance. A manual handle shall be provided for maintenance.

Switches composed of molded case breakers, contactors, or similar components not specifically designed for automatic transfer switch applications will not be acceptable.

2-3.01.02. Bypass-Isolation Switch. Not used.

2-3.02. Control System. The control system shall consist of all control devices necessary to operate the switch as described. The system shall incorporate a microprocessor control module connected to the power transfer components by a wire harness and keyed disconnect plugs. The control module shall be completely enclosed with a protective cover and shall be mounted separately from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on plug-in circuit boards. All interface relays shall be identical and shall be control grade, plug-in type, with dust covers.

All control components shall meet or exceed the voltage withstand capability in accordance with IEEE C37.90.1 and NEMA ICS 1.

2-3.02.01. Performance. The automatic transfer switch shall be designed to function in accordance with the following requirements:

a. The voltage of each phase of the normal source shall be monitored and the pickup voltage shall be adjustable from 85 percent to 100 percent of nominal, and the dropout voltage shall be adjustable from 75 percent to 98 percent of the pickup value. The transfer to emergency will be initiated upon reduction of the normal source to 85 percent of the normal voltage, and retransfer to normal shall occur when the normal source restores to 90 percent of the normal voltage.

b. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals shall be provided. The time delay shall be field adjustable from 0.5 to 6 seconds and shall be factory set at 1 second.

c. A time delay to retransfer to the normal source shall be provided. The time delay shall be automatically bypassed if the emergency source fails and the normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and shall be factory set at 10 minutes.

d. An in-phase monitor shall be provided to control transfer so motor load inrush currents do not exceed normal starting currents. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and shall permit transfer only at acceptable values of voltage, phase relationship, and frequency differential.

e. An unloaded running time delay for engine-generator cool-down shall be provided. The time delay shall be field adjustable from 0 to 60 minutes and shall be factory set at 5 minutes.

2-3.02.02. Indication. The automatic transfer switch shall include indication features in accordance with the following requirements:

a. A detailed step-by-step operating instruction plate shall be provided on the front of the switch.

b. Indicating lights or microprocessor control display indication shall be provided for, but shall not be limited to, the following:

Normal source available.
Emergency source available.
Bypass switch in normal position.
Bypass switch in emergency position.
Automatic transfer switch isolated.
Automatic transfer switch inhibit.
Automatic transfer switch in normal position.
Automatic transfer switch in emergency position.
Automatic transfer switch in test mode.

c. One auxiliary contact shall be provided that is closed when the automatic transfer switch is connected to the normal source and one contact that is closed when the automatic transfer switch is connected to the emergency source.

d. A contact, which will close when the normal source fails, shall be provided to initiate engine starting. The contact shall be rated 10 amperes, 32 VDC and shall be gold plated for low voltage service.

2-3.03. Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61. Field painting, other than touchup painting, shall not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

2-3.04. Shop Tests. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and for compliance with the governing standards. Certified test results shall be submitted to Design Builder before the equipment is shipped.

PART 3 - EXECUTION

3-1. INSTALLATION. The transfer switch will be installed in accordance with Electrical Equipment Installation section.

3-2. TRAINING. The manufacturer’s representative shall provide training of Owner’s personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

Section 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing the design of lightning protection systems and the furnishing and installation of lightning protection equipment for the following structures:

Operations Building

Lightning protection systems shall be designed, furnished, installed, and tested as specified. Lightning protection equipment shall meet the requirements specified herein.

Lightning protection systems shall consist of, but not be limited to, air terminals; main, bonding, and down conductors; ground terminals; and all required connectors and fittings required to complete the system.

The lightning protection system shall include the bonding of all roof-mounted mechanical equipment, roof drains, roof mounted ladders, chimneys, antennas, and other roof mounted metal objects.

1-2. GENERAL. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor and obtain all inspections to complete the work as specified, and in compliance with all codes, standards, and regulations.

Contractor shall provide coordination with other contractors and supervision of installation as needed during construction.

The design of the system shall include determination of the overall lightning hazard for the geographic location of the project and for the structures, the selection of Class I and/or Class II materials, the need of corrosion protection for the copper and/or aluminum components used, and consideration of other pertinent factors. The design shall produce a zone of protection from lightning to prevent personal injury, structural damage, and equipment downtime.

Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of UL unless exceptions are noted by Engineer.

The system shall be installed by an installer who has UL listing and subscribes to the UL Follow-Up Service.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Governing Standards. All system components furnished under this section shall be designed in accordance with ANSI/UL 96 - Lightning Protection Components. All lightning protection systems furnished under this section shall be designed, constructed, and tested in accordance with UL 96A – Installation Requirements for Lightning Protection Systems and ANSI/NFPA 780 – Standard for the Installation of Lightning Protection Systems.

Lightning protection systems shall be bonded to grounding electrode systems in accordance with the National Electrical Code.

1-2.04. Workmanship and Materials. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, unless required by tests.

1-3. SUBMITTALS. Complete certification of design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming the system, shall be submitted in accordance with the Submittals Procedures section.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. QUALITY ASSURANCE. The lightning protection system shall be inspected and tested after installation by conducting continuity and ground resistance tests as well as a visual inspection. Inspection results and test data shall be submitted in accordance with the Submittals Procedures section. Upon

completion of the installation, Contractor shall apply for and deliver the UL Master Label Certificate of Inspection for each structure/building.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. The system components shall be manufactured by a company that has been specializing in the design and manufacture of UL listed lightning protection equipment for at least 5 years.

2-2. MATERIALS. All manufactured and fabricated components shall conform to NFPA 780 Class I or Class II as needed for the structures on which they will be installed. The system components shall be fabricated from the following metals:

Conductors	Copper.
Air Terminals	Copper or bronze.
Grounding Electrodes	Copper clad steel.
Fasteners	Copper or bronze.
Bimetallic Fasteners	Bronze and aluminum.

Aluminum conductors and air terminals shall be mounted on aluminum surfaces only.

All materials furnished for the lightning protection system shall bear the inspection label of UL.

PART 3 - EXECUTION

3-1. INSTALLATION. The lightning protection system shall be installed in a neat and inconspicuous manner so all components will blend in with the appearance of the building. All conductors shall be concealed or semi-concealed during construction using methods recommended in NFPA 780 and UL 96A.

Air terminals shall have base supports designed for the surface on which they are used and shall be securely anchored. All exposed metal eave troughs, roof vents, guy wires, antennas, and air handling equipment shall be bonded to the lightning protection system in such a way that two paths to ground are provided.

The lightning protection system shall be bonded to structure/building electrical ground rings wherever they are available.

End of Section

Section 26 50 01

PERFORMANCE LIGHTING

PART 1 - GENERAL

1-1. SCOPE. Scope of supply shall include designing, furnishing, and installing the plant lighting and convenience receptacle system as specified herein.

1-2. Items Furnished by Others and Interfaces. Not used.

1-3. PERFORMANCE AND DESIGN REQUIREMENTS. Performance and design requirements for the equipment and materials to be furnished under this section of these specifications are indicated herein.

1-3.01. Design Requirements. The lighting system shall be designed by the Electrical Subcontractor to provide personnel with illumination for plant operations under normal conditions, essential lighting in selected process areas, electrical/control areas and means of egress under emergency conditions. The power supply for the normal lighting system shall be from Electrical Subcontractor provided 120/208, 3-phase, 4 wire lighting transformer/panelboards. The power supply for convenience receptacles shall be from Electrical Subcontractor provided 120/208 volt, 3-phase, 4 wire lighting transformer/panelboards. Emergency egress lighting shall be provided with normally "off," emergency "on" integral lead acid battery powered emergency lighting units with chargers rated for 1.5 hours minimum and in accordance with UL 924.

The lighting system shall be designed in accordance with the codes and standards noted in section 1-5 below. The illumination levels shall be as per the electrical drawings.

Panelboard breakers shall be used to switch light fixtures for large open interior and exterior spaces. Electric power to light fixtures in dedicated rooms shall be switched with wall mounted light switches or other devices as required by the local state Energy Code, and located at the entrance to all rooms on the latch side of the door. Light fixtures located outside above doors shall be provided with integral photoelectric controllers. Outdoor fixtures shall be controlled from lighting contactors with H-O-A switch on cover and coil operated by photocell.

The lighting shall have interface with the Plant Control System (PLC) so it can be turned on and off from the Plant Control System.

Convenience receptacles shall be grounding type and spaced to provide access to any equipment area with a 100 foot extension cord. A minimum of one receptacle shall be provided on each wall of every room. Weatherproof GFI receptacle shall be provided for exterior areas. Convenience receptacles shall

be limited to six per circuit, with a branch circuit loading of 180 watts for each receptacle, unless specific conditions necessitate other requirements.
Lighting in process areas shall be designed with the equipment in the space in mind and to avoid physical interferences with tray, piping and HVAC ducts which are being designed by others, as well as shadows/light blockages from adjacent equipment.

For lighting system materials, the following requirements shall also apply in addition to the requirements of following sections:

Section 26 05 11 - Electrical.

Section 26 05 83 - Electrical Equipment Installation.

1-3.02. Design Execution. The design process shall be fully tracked and managed from concept through execution.

1-4. SUBMITTALS. All submittals shall be in accordance with Supplemental Procedure section. In addition to equipment submittals the Electrical Subcontractor shall also submit the following information:

- A comprehensive/complete drawing list shall be provided at the start of the project and maintained through project completion. List shall include drawing names, drawing numbers, as well as expected/actual release dates for review and construction.
- Calculations verifying lighting levels and panelboard electrical loading.
- Lighting system drawings indicating all light fixtures, switches, receptacles, panelboards, sized circuiting, and quantities of materials including model numbers. Drawing backgrounds shall include equipment in the area. Elevations and plan locations shall be established for lighting materials to avoid interferences.
- Panelboard diagrams indication panel configurations, electrical load per breaker, breaker sizes, and description of load.
- Energy calculations required by (Fill in State) Code.
- Native drawing files in CAD format (if required by EPC Contract).
- Electronic and hard-copy bills of quantity in MS Excel format for all equipment and devices.

Lighting calculations shall be average maintained values determined from a working plane height of 30 inches above the floor for interior and at floor level for exterior. Light loss factors shall be determined as recommended by IESNA. Illumination point values shall be indicated on a background of the area being illuminated with equipment indicated on the background. The major equipment shall be modeled in the calculation. Panelboard load sheets shall be prepared with load per branch breaker and then overall panel loading. Voltage drop

calculations shall be prepared for some of the longer branch runs to verify wire size used in design. Energy calculations or worksheets shall be prepared if required by energy codes. Calculations shall be given unique file numbers as directed by the Purchaser and have cover sheets describing the calculation.

The drawings shall be prepared in the following format. Each drawing label shall indicate the drawing content and system type. Physical layout drawings shall include all floor plans drawn to a minimum scale of 3/16 inch equals one foot with the same north orientation. A legend shall be provided to describe the symbols used on the drawings. Drawings shall be corrected by the Subcontractor after system installation to show the as-built configuration of the systems. The drawings shall be stamped by a (Fill in State) registered professional electrical engineer.

1-5. CODES AND STANDARDS. Work performed under these specifications shall be done in accordance with the following codes and standards. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply.

These references shall govern the work except where they conflict with the Design-Builder's specifications. In case of conflict, the latter shall govern to the extent of such difference:

Work	In Accordance With
Lighting Design	Illumination Engineering Society (IES) Lighting Handbook 10th edition
Emergency and Exit Lighting	National Fire Protection Association (NFPA) 101, Life Safety Code. Exterior Structures will be classified as open structures in accordance with NFPA 101 and therefore will be exempt from emergency lighting requirements per Article 11.2.2.9
Luminaires	
Fluorescent	UL 542, 935, 1598
High intensity discharge	UL 496, 1029, 1598
Light emitting diode (LED)	UL 8750
Emergency and emergency power equipment	UL 924

Work	In Accordance With
Hazardous area	UL 844
Duplex and single receptacles	UL 498, 943, 1010, 1449, 1682, 1686
Switches, dimmers, contactor, and photocells	UL 20, 508, 773, 894, 1472
Device plates and outlet boxes (unfinished areas)	UL 514

1-6. MATERIALS. The following materials shall be used:

Component	Material
Switches	
Housing and operating levers	Phenolic compound
Device plates	
Finished areas (metal)	Type 430 satin stainless steel
Unfinished areas	Formed sheet steel coated with zinc of cadmium
Weatherproof receptacle and switches	
Plates and lift cover	Cast aluminum
All other metal parts	Stainless steel or Monel metal

1-7. TEST REQUIREMENTS. The testing of the lighting system shall be the responsibility of the Electrical Subcontractor.

PART 2 - PRODUCTS

2-1. LUMINAIRE DEVICES. Luminaires shall be as specified in the specification Section 26 05 11.

2-2. LUMINAIRE SUPPORTS. All required luminaire supports, hangers, clamps, hardware, and fasteners shall be furnished and installed as required for a rigid support. Supports shall be from the building structure support steel, walls, or standalone light poles for exterior lighting. Chain supported luminaires are not acceptable. Supports shall be designed for the project seismic criteria.

2-3. LIGHTING AND CONVENIENCE RECEPTACLE RACEWAY. The following raceway and raceway fittings (minimum size 1/2 inch) for use in lighting and convenience receptacle circuits shall be provided.

Raceway Type	Use
Electrical metallic tubing (EMT)	Installed in indoor nonhazardous areas
Rigid galvanized steel	Outdoors above grade and indoor hazardous areas
Flexible metallic tubing	Luminaire taps in finished areas

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with the Electrical Equipment Installation section.

End of Section

Section 28 10 01

FACILITY SECURITY SYSTEM

PART 1 - GENERAL

1-1. SCOPE. This section covers the design, furnishing, installation, configuration, testing and commissioning of all security equipment, materials, cabling, conduits, and other accessories needed for a complete security system.

The facility security shall be implemented for the entire site. The security installation shall be UL certified.

Security System Supplier shall be responsible for the complete design including locating the devices and sizing and routing all the cables and conduits for complete security system specified herein.

All security equipment racks shall be located in the electrical room. A single power feed (120VAC, 30A) circuit will be provided for each equipment rack. The Supplier shall be responsible for providing all the necessary power transformer within the equipment rack for all the furnished security devices. Power supplies for all furnished security devices shall be fed from the furnished equipment rack at each location.

All low voltage signal and communication cables shall be routed in separate conduits from the 120VAC power cables.

1-2. GENERAL. Security apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

Security materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Coordination. Security work shall conform to the construction schedule and the progress of other trades.

1-2.04. Anchor Bolts and Expansion Anchors. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch [19 mm] will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

1-2.05. Drawings. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1-3. CODES AND PERMITS. All work shall be performed and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

ANSI	American National Standards Institute.
AWG	American Wire Gauge.
ICEA	Insulated Cable Engineers Association.
IEEE	Institute of Electrical and Electronics Engineers.
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association.
NFPA	National Fire Protection Association.
CEC	California Electrical Code

1-4. SEISMIC DESIGN REQUIREMENT.

1-4.01. Seismic Design Requirements. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-5. IDENTIFICATION.

1-5.01. Security Equipment. Security equipment hall be provided with nameplates identifying the related equipment.

1-5.02. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated black-over-white plastic, with 1/8 inch [3 mm] engraved letters, and shall be securely fastened to the circuit breakers.

1-6. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Overall System Diagram

Cable and Conduit lists

Design and Installation Drawings and data.

Operating manuals.

1-6.01. Submittal Identification. Information covering all materials and equipment shall be submitted for review in accordance with the Submittals Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

a. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.

b. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.

c. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.

d. Schematics and connection diagrams for all security equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

e. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer’s descriptive bulletins and product sheets.

1-7. PROTECTION AND STORAGE. During construction, the insulation on all equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

Each building listed below shall be equipped with the security devices specified herein.

1. Operations Building
2. RO Building
3. Maintenance Building
4. Electrical Building

The following security devices shall be provided.

1. An intelligent single door controller for each building for all doors. Only the main entrance door of each building has motorized door.
2. A card reader for each building entrance door and for the site main entrance gate.
3. A badge making machine with 50 cards.
4. A magnetic door switch for each building entrance door.
5. An electric door lock for each building entrance door will be furnished by others but shall be installed by Electrical Subcontractor.
6. An outdoor rated, IP camera with weather proof and tampered housing for each building entrance door and for the site main entrance gate. The IP cameras shall have zoom and night vision capacity.
7. Motion detectors for the Operations Building and Maintenance Building
8. An Ethernet switch.
9. A 19" freestanding rack located in the Operations Building.
10. A rack mounted UPS with 2 hours battery time for each location.
11. A Networked Video Recorder (NVR) to record all CCTV's video. NVR shall provide at the minimum 30 days storage of video.
12. A security computer with security software for controlling all the security devices. The security software shall allow the operator to set security clearance for different staff, set security zone, monitor and alarm any security events, provide CCTV image, and provide remote access for the operator to the system.

PART 3 - EXECUTION

3-1. INSTALLATION, TESTING, AND COMMISSIONING. All material, equipment, components, cables, conduits, and necessary accessories for complete security system shall be installed, configured, tested, and commissioned for operation by the Supplier.

3-2. CABLE AND CONDUIT INSTALLATION.

3-2.01. General. Except as otherwise specified or indicated on the Drawings, cable and conduit shall be installed according to the Electrical section 16050 of this Contract.

3-3. WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION.

3-3.01. General. Except as otherwise specified or indicated on the Drawings, all security accessories shall be installed according to the Electrical section 16050 of this Contract.

3-4. EQUIPMENT INSTALLATION. Except as otherwise specified or indicated on the Drawings, equipment shall be installed according to the Electrical Section 260511.

3-5. TRAINING. The Supplier shall provide training of the system to the Owner.

End of Section

Section 28 31 16

FIRE DETECTION AND ALARM SYSTEM

PART 1 – GENERAL

1-1. SCOPE. This section covers the design and the furnishing and installation of a fire detection and alarm system. All associated equipment, devices, and controls necessary for proper operation shall be included.

The design of the system shall consist of, but shall not be limited to, a determination of the applicable fire and safety codes; an analysis of the various plant ambient temperatures, noise levels and environments (wet, dusty, oily, corrosive, hazardous, etc.); the number and type of detectors, alarm indicators, and manual stations required; and the proper wiring and mounting configurations.

Peripheral components as specified shall be located as indicated on the Drawings and provided in sufficient number and located as needed to meet all applicable codes.

The fire alarm system supplier shall coordinate with the fire suppression system supplier and other mechanical supplier for monitoring of sprinkler system flow switches and anti-tampering switches, sprinkler system alarm bell, backflow preventer flow switches and anti-tampering switches, and other associated devices.

1-2. GENERAL. Supplier shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor to complete the work as specified, and in compliance with the codes, standards, and regulations listed below.

1-2.01. Contractor's Qualifications. The system design, equipment, installation, and installation supervision furnished under this section shall be provided by a single manufacturer or supplier who shall be UL certified for fire alarm installation.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards.

a. California State Fire Marshal's Regulations for Safety to Life from Fire and Emergencies in Buildings and Structures, and General Fire Protection.

b. National Fire Protection Association, NFPA 45, 71, 72, 90A, and 101.

c. California Fire Code and Building Code

City of Morro Bay Fire Department Regulations

d. Morro Bay City Electrical Code.

e. National Electrical Code, Article 760.

All fire alarm equipment and materials, devices, and assemblies shall be listed and/or labeled by Underwriters' Laboratories, Factory Mutual, or another accepted testing laboratory for the intended purpose where acceptable to the authority having jurisdiction. The equipment shall not be altered, installed, or modified in any way that would void the label or listing.

All control equipment shall have transient voltage protection devices in compliance with UL 864.

The system controls shall be UL listed for Power Limited Applications according to NEC 760. All circuits shall be marked in accordance with NEC 760.10.

1-2.05. Nameplates. Major components of equipment shall be identified with a permanently affixed nameplate bearing the manufacturer's name and address, and type or style and catalog number of the item.

1-2.06. Tags. Keys and locks shall be furnished with tags bearing stamped identification numbers. Cable and conduit runs, wiring circuits, and all spare parts supplied to maintain the system shall be furnished with hard phenolic or stainless steel tags.

1-2.07. Power Requirements. Power supply to the fire alarm control panel (FACP) will be 120 volts, 60 Hz, single phase.

The alarm system shall include an automatically recharged backup power supply with sufficient battery capacity to operate the entire system in the normal supervisory mode for 24 hours and then sound all alarms for 5 minutes. In the event of power failure, the system shall automatically transfer to the standby batteries.

All external circuits requiring system-operating power shall be suitable for 24 volt dc service and shall be individually fused at the control panel.

1-2.08. Spare Parts. The Fire Detection System and Alarm supplier shall propose a recommended spare part list with pricing information per General Terms and Conditions.

1-3. SUBMITTALS. Complete electrical wiring diagrams; assembly and installation drawings; detailed specifications; and data covering the materials used and the parts, devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with the Submittal Procedures section.

In addition to the submittals to Design-Builder, Supplier shall submit complete plans and information to the local fire department for review. Supplier shall provide signed and sealed plans by a registered fire protection engineer in the state. The equipment submittals shall include the following:

A complete description of all system components, including certification of listing by the required testing laboratory.
Complete sequence of operation for all functions of the system.
Complete system wiring diagram for all components and interfaces to equipment supplied under other sections.
Location drawings for all controls, alarm actuating devices, and audiovisual alarm signaling devices.
A listing of the manufacturer's representatives responsible for installation and service.
Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
Operation and maintenance manuals.

1-4. SYSTEM DESCRIPTION. The fire alarm system shall be operated and monitored by multiple fire alarm control panels (FACPs), located in the following locations:

1. Operations Building – Main Fire Alarm Control Panel, 95-FP-LCP-0001
2. Maintenance Building – 96-FP-LCP-0001
3. RO/UV Building – 50-FP-LCP-0001, and
4. Electrical Building – 80-FP-LCP-0001

The main FACP shall be located in the Operation Building lobby. The system shall automatically initiate fire alarm signals whenever any manual or automatic fire detection device is placed in an alarm mode. The system shall transmit a signal to the municipal alarm connection through redundant telephone lines, HVAC systems, the plant control system, and other plant systems as indicated in the activation sequence herein. The FACP shall annunciate and sound local alarms for detection device alarm conditions, system trouble, or circuit failure. Alarm signals shall be consistent throughout the building or site. The operation

of any alarm initiating device shall cause audible and visual alarms to sound and to be displayed throughout the building by applicable codes. A key-accessible reset function shall reset the alarm system after alarm initiating conditions have been cleared.

The system functions shall include area detection, manual stations, duct smoke detection, sprinkler system monitoring, sprinkler system electric bell actuation, backflow preventer monitoring, and other fire related systems as required by codes.

The system shall automatically activate smoke detected audiovisual annunciation equipment whenever an area smoke detector or duct smoke detector is in alarm mode. The system shall identify the device and the location. For duct smoke detection, the system shall simultaneously provide an isolated alarm contact indication to the temperature control system to deactivate the HVAC systems as indicated in the HVAC sequence of operations on the Drawings.

1-4.01. Fire Alarm System.

a. Initiating device, notification device, and signaling line circuits shall be NFPA 72, 3-4, Class A. The system shall monitor incoming power and standby power. In addition to the FACP, the system shall include heat detectors, smoke detectors, audiovisual alarm units, end-of-line devices, manual pull stations wiring connections to devices, outlet boxes, junction boxes, and all other necessary equipment for a complete operating system.

b. System trouble, including grounded or open supervised circuit, power failure, system battery low voltage, or system failure, shall cause the system to enter a trouble mode and display visual and audible alarms. The visual alarm shall be displayed until the initiating trouble has been cleared.

1-4.02. Activation Sequence. The alarm sequence initiated by the activation of any manual station, automatic detection device, duct smoke detector, sprinkler flow switch shall be as follows:

a. Selected audible alarm indicating devices shall sound a march time code in the building until silenced by the alarm silence switch at the FACP.

b. Selected visual alarm indicating devices shall display a continuous strobe pattern in the building until the system is reset.

c. A supervised signal shall notify the local fire department or the central processing unit.

d. For duct smoke detection, the system shall simultaneously provide an isolated alarm contact indication to the temperature control system to deactivate the HVAC systems as indicated in the HVAC sequence of operations on the Drawings.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. All panels and peripheral devices shall be the standard products of a single manufacturer, and the manufacturer's name shall be displayed on each component. The system shall be manufactured by Bosch Security Systems; Gamewell-FCI; Notifier; Siemens Building Technologies; or Simplex Grinnell.

2-2. REMOTE SENSORS.

2-2.01. Fire Alarm Pull Stations. Addressable pull stations shall communicate the station's status (alarm, normal) over two wires that also supply power to the pull station. The address shall be set on each station. The stations shall be manufactured from high-impact red Lexan. Lettering shall be raised and painted white. When activated, the stations shall mechanically latch and remain latched until they are manually reset using a key common to all locks.

The location "address" of the pull stations shall be capable of field programming from the FACP over the signaling line circuit.

2-2.02. Smoke Detectors. Analog addressable smoke detectors shall be of the photoelectric type and shall communicate actual smoke chamber values to the system control panel. The sensors shall be solid-state, containing no radioactive material, and shall be capable of detecting up to seven sensitivity levels between 0.5 and 3.7 percent.

The sensors shall be plug-in units mounted on a twist-lock base. Smoke detector bases shall be common with the heat detector bases and shall be compatible with other addressable detectors and addressable manual stations on the same circuit. The detectors shall be suitable for both ceiling and wall mounting and shall have a 30-mesh insect screen. Detector bases shall contain a light emitting diode that will flash each time it is scanned by the control panel. When the sensor detects smoke or fails, the diode shall illuminate to indicate the abnormal condition. When required, detector bases shall be provided with a relay driver output that may be controlled either automatically or manually from the control panel.
Each detector shall contain a magnetically actuated test switch for alarm testing at the sensor location.

Smoke detectors for installation in ducts shall be as specified above and shall be

provided with auxiliary dpdt relays, remote LED alarm indicators, and key-operated test stations.

2-2.03. Heat Detectors. Addressable heat detectors shall be ambient compensated combination rate-of-rise and fixed temperature types. The fixed temperature operation of the sensor shall be selectable for 174°F. Rate-of-rise operation shall be selectable for either 15 or 20°F per minute and shall be self-restorable.

The thermal type sensor shall be a plug-in unit that mounts on a twist-lock base. Bases shall be as described for smoke detectors.

2-2.04. Audiovisual Alarm Units. Alarm units shall consist of a horn and a Xenon flashtube installed in a surface or semi-flush wall- or ceiling-mounted enclosure. The horn shall have polarized connections with separate leads for in/out wiring for each leg of the associated signal circuit. Sound level shall be 90 dB at 10 feet [3 m].

The visual unit shall operate on 24 volts dc and shall have a white translucent pyramidal lens with the word "FIRE" imprinted in red lettering. The flash rate shall be 1 to 1.5 times per second.

2-2.05. Auxiliary Relays. Auxiliary relays shall be supplied where required. The relays shall be of high quality and shall be fitted with dusttight plastic covers. The contacts shall be at least 1/8 inch in diameter, of gold-plated silver cadmium oxide, rated for 5 amperes at 115 volts ac.

Auxiliary relays shall be provided in the RO building fire alarm panel to provide the following 2 alarms to the plant control system.

1. Fire alarm (Any fire alarms from the entire fire alarm system).
2. Trouble alarm (Any trouble alarms from the entire fire alarm system).

2-2.06. Addressable Input Modules. Each external dry contact input from sprinkler system flow switches, tamper switches, backflow preventer flow switches, tamper switches, and other required auxiliary inputs shall be equipped with addressable input modules designed to provide circuit monitoring and point identification of dry contact inputs.

2-3. PANELS.

2-3.01. Fire Alarm Control Panel. The control panel shall be an analog/addressable type fire alarm control panel. The panel enclosure shall be

constructed from steel, in compliance with UL 864, with front access door, and shall be surface wall-mounted.

The control panel shall be of modular construction, with solid-state, microprocessor-based electronics, and shall display only the primary controls and functions essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions. A local audible device shall sound during alarm, trouble, or supervisory conditions. The sound that identifies each condition shall be readily distinguishable without having to view the panel. The audible device shall also sound during each key press to indicate that the key has been pressed. The panel shall be fully field programmable from the keypad and capable of downloadable programming from a Windows-based application program. The panel shall include self programming logic capable of automatically programming new addressable field initiating devices.

The following primary controls shall be visible through a front access panel:

Eighty-character liquid crystal display, backlit.

Red system alarm LED.

Yellow supervisory service LED.

Yellow trouble LED.

Green "power on" LED.

Alarm acknowledge key.

Supervisory acknowledge key.

Trouble acknowledge key.

Alarm system key.

System reset key.

Manual evacuation (drill).

The control panel shall include the following functions:

Setting of time and date.

LED testing.

Listing of alarm, trouble, and abnormal conditions.

Separate enabling and disabling of each monitor point.

Separate activation and deactivation of each control point.

Changing operator access levels.

Walk-test enable.

Running diagnostic functions.

Displaying software revision level.

Displaying historical logs.

Displaying card status.

Point listing.

The following lists from the points list menu shall be available for maintenance purposes:

All points by address.

Monitor points.

Auxiliary controls.

Feedback points.

Pseudo points.

LED/switch status.

Scrolling through menu options or lists shall proceed in a self-directing manner, guided by prompting messages. The controls for the points list menu shall be located behind an access door.

The control panel shall contain a back lighted 2 line by 40 character liquid crystal display. To conserve standby battery power in the event of an ac power failure, the display shall be lit only during keypad activity.

The display shall consist of both upper case and lower case letters. Lower case letters shall be used for soft key titles and for prompting the user. Upper case letters shall be used for system status information. A cursor shall be visible when information is being entered.

All wiring shall be brought to terminal strips for field connections.

2-3.01.01. Front Panel Operation and Capabilities. Under normal conditions, the front panel shall display a "SYSTEM IS NORMAL" message and the current time and date.

Should an abnormal condition be detected, the appropriate alarm, supervisory, or trouble LED shall flash. The audible signal shall pulse for alarm conditions and sound steady for trouble or supervisory conditions.
The LCD shall display the following information pertaining to the abnormal condition:

Location label (40 characters available).

Type of alarm device - smoke detector, pull station, and water flow sensor.

Point status - alarm, trouble.

Buttons shall be provided to acknowledge alarm conditions and to silence audible alarms in compliance with NFPA 72.

2-3.01.02. Alarm Silencing. When the "ALARM SILENCE" button is pressed, all alarm signals shall cease. Alarm signals shall not be silenced during "alarm silence inhibit" mode.

2-3.01.03. System Reset. Using the "SYSTEM RESET" button shall restore the system to its normal state after an alarm condition has been remedied.

The LCD display shall step the user through the resetting procedure with simple printed messages.

2-3.01.04. Device Status. Complete status of all addressable field devices shall be available through use of the operator keypad and front panel display.

2-3.01.05. History Logging. The system shall be capable of logging and storing 500 alarm, trouble, and operation events in a history log. These events shall be stored in a battery-protected random access memory. Each recorded event shall include the time and date of the occurrence.

2-3.01.06. Silent Walk Test with History Logging. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. After logging the alarm, the panel shall automatically reset.

The momentary disconnection of an initiating or indicating device circuit shall be silently logged in the historical data file as a trouble condition. After logging the trouble condition, the panel shall automatically reset.

Should the walk test feature be on for an inappropriate length of time, it shall automatically revert to the normal mode.

The control panel shall be capable of supporting up to eight separate testing groups, one of which may be in a testing mode while the other (nontesting) groups may be active and operating as normally programmed. After testing is completed, testing data may be retrieved from the system in chronological order to ensure device/circuit activation.
Should an alarm condition occur from an active point that is not in walk test mode; it shall initiate the normal alarm sequence.

2-3.01.07. LED Supervision. All LEDs shall be supervised for burnout or

disarrangement. Should a problem occur, the LCD shall display the location numbers of the module and the LED to facilitate location of the affected LED.

2-3.01.08. System Trouble Reminder. In the event of a trouble condition within the system, with the audible signal silenced, the trouble signal shall resound at 24 hour intervals as a reminder that the fire alarm system is not 100 percent operational. Both the time interval and the trouble reminder signal shall be programmable to adapt to the application.

2-3.01.09. Operator Access Levels. Operator access to system functions shall be limited by a key switch and multiple levels of password protection.

The following functions shall be protected:

Alarm Silence.

System Reset.

Set Time/Date.

Manual Control.

On/Off/Auto Control.

Disable/Enable.

Clear Historical Alarm Log.

Clear Historical Trouble Log.

Walk Test.

Change Alarm Verification.

Acknowledge keys shall also require privileged access to acknowledge points. If the operator presses an acknowledge key with insufficient access, an error message will be displayed. The points shall scroll with acknowledge key presses to view the points on the list, but the points will not be acknowledged in the database.

2-3.01.10. Wiring. Intermodule wiring for common system functions shall be installed in a supervised cable bus. Disarrangement of the bus shall cause a distinctive "Cable Supervisory" LED to be illuminated in addition to activating the common trouble indicators.

Detector and signal circuits and wiring may be nonpower-limited type and shall comply with the applicable articles of the NEC.

2-3.02. Enclosures. A cabinet of sufficient size shall be provided to accommodate all equipment required. The door of the cabinet shall be equipped with locks and a continuous hinge, providing protection from tampering, yet allowing full view of the various lights and controls. Indoor enclosures shall be of

a NEMA type suitable for the area designation. Outdoor NEMA Type 4X enclosures shall be stainless steel.

2-4. CABLE AND RACEWAYS.

2-4.01. Cable. Cable used in the fire alarm system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial fire alarm systems and UL listed for indoor/outdoor installations. All cable required for the system shall be furnished by the Supplier.

2-4.02. Raceways. All cable shall be installed in conduit furnished under this section. All conduit shall conform to the applicable paragraphs of the Electrical section 26 05 11.

PART 3 - EXECUTION

3-1. GENERAL. All work shall be installed as indicated on the Drawings, and in accordance with the manufacturer's diagrams and recommendations, except where otherwise indicated.

All junction boxes furnished hereunder shall be painted red and permanently labeled "FIRE ALARM". A consistent wiring color code shall be maintained throughout the installation.

Installation of equipment and devices that connect to equipment furnished under other sections, or furnished by the Owner, shall be closely coordinated with the suppliers of the equipment and with Owner.

After completion of the installation, Contractor shall clean the inside and the outside of the fire alarm equipment and shall remove all dirt and debris from the site.

3-1.01. Cable. Cable shall be installed as described in the cable installation paragraphs in the Electrical section 26 05 11. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

All wiring going to the fire alarm control panels except the power feed cable and the communication cables shall be furnished and installed by the Supplier.

The power feed cables, communication cables between the fire alarm control panels, the control cables between the RO building fire alarm panel and the plant PLC, and the redundant telephone lines for the main fire alarm control panel in Operations Building will be by others.

3-1.02. Raceways. Conduit shall be installed as described in the conduit installation paragraphs in the Electrical section 26 05 11.

3-1.03. Testing. Supplier shall notify Design-Builder at least 30 days before the performance and acceptance tests are to be conducted. The tests shall be performed in the presence of Design-Builder and Local Fire Marshal. The Supplier shall furnish all instruments and personnel required for the tests. A complete test report and letter of completion shall be submitted to Design-Builder. The tests shall be performed by, or under the supervision of, a qualified representative of the fire alarm system manufacturer and shall include the following:

a. Verify that the system is free of grounds or open circuits. The FACP shall indicate when a ground or an open circuit exists.

b. Verify that all alarm signal devices, stations, transmitters, automatic detectors, and supervisory devices are functioning as specified.

c. Test each fire alarm device and circuit. Individually activate each manual initiating station and verify correct alarm operation and control panel response. Individually test each automatic initiating device and verify correct alarm operation, control panel response, and remote equipment operation.

d. Test battery backup systems for specified capacity.

e. Repeat test to verify correction of any defect found in the initial testing.

3-2. TRAINING. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification.

End of Section

Section 33 05 14

MANHOLE AND VAULT COVERS AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the fabrication and erection of iron manhole and vault covers and accessories suitable for installation in manholes, vaults, slabs, electrical handholes, and other applications where a floor access hatch is not required. For floor access hatches and doors see the specification section of the same name.

Note that this section does not cover sanitary sewer or stormdrain manhole covers. Those particular covers fall under the City of Morro Bay Standard Details.

Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1-2. SUBMITTALS. Complete data, detailed drawings, and setting or erection drawings covering all materials shall be submitted in accordance with the Submittals Procedures section. Each separate piece shall be marked.

1-3. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Materials shall be stored on blocking and protected from the weather so that no metal touches the ground and water cannot collect thereon.

PART 2 - PRODUCTS

2-1. GENERAL. Materials work shall be fabricated in conformity with dimensions, arrangements, sizes, and weights or thicknesses as specified or as indicated on the Drawings.

All members and parts shall be free of warps, local deformations, and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. All field connection materials shall be furnished.

2-2. DESIGN REQUIREMENTS. Manhole and electrical vault covers and frames shall be cast iron assemblies specifically intended as covers. Manufacturer, product number, and type shall be as specified.

All covers and frames shall be capable of carrying an AASHTO HS-20 street loading unless specifically indicated as light duty. An equivalent heavy duty cover and frame may be substituted for the indicated light duty cover and frame.

2-3. MATERIALS. Materials, appurtenances, and finishes used in the manufacturer of manhole and electrical handhole covers and frames shall be as indicated. Unless otherwise required, materials, appurtenances, and finishes shall be the manufacturer's standard for the type of each cover indicated.

Circular Covers and Frames	Sanitary and storm manhole covers and frames shall be per City of Morro Bay Standards.
Light Duty	Cast iron; Clay & Bailey "2020", Neenah "R-1737", or equal.
Heavy Duty (Subject to Vehicular Traffic)	Cast iron; Clay & Bailey "2008BV", Neenah "R-1736", or equal.
Rectangular Covers and Frames	
Light Duty	
Square	Cast iron; Neenah "R-6660", or equal.
Rectangular	Cast iron; Neenah "R-6661", or equal.
Heavy Duty (Subject to Vehicular Traffic)	
Square	Cast iron; Neenah "R-6662", or equal.
Rectangular	Cast iron; Neenah "R-6663", or equal.
Manhole Steps	Per City of Morro Bay standards.

PART 3 - EXECUTION

3-1. INSTALLATION. Prior to installation all loose rust shall be removed from castings and one coat of coal tar epoxy shall be applied to surfaces embedded in concrete. Materials shall be erected and installed in conformity with the dimensions and arrangements specified or indicated on the Drawings and as recommended by the manufacturer.

After erection covers and frames shall be cleaned. Product finishes damaged during erection, shall be repaired as recommended by the manufacturer.

End of Section

Section 33 13 13

CLEANING AND DISINFECTION OF WATER PIPELINES

PART 1 - GENERAL

1-1. SCOPE. This section covers cleaning of potable and non-potable water pipelines and disinfection of all potable water pipelines installed under this Contract.

Pipeline pressure and leakage testing is covered in the Pipeline Pressure and Leakage section.

1-2. GENERAL.

1-2.01. Coordination. Contractor shall coordinate cleaning and disinfection work with adjacent work as necessary to preclude work interferences or duplication of effort and to expedite the overall progress of the work.

Contractor shall provide all necessary piping, piping connections, temporary valves, backflow preventers, flowmeters, sampling taps, pumps, disinfectant, neutralization agents, chlorine residual test apparatus, and all other items of equipment or facilities necessary to complete the cleaning and disinfection work.

Water for cleaning and disinfection work will be coordinated by the Design-Builder.

Unless otherwise specified, final cleaning and disinfection work shall not be performed until after hydrostatic testing of the pipelines and any resulting repair work completed.

1-2.02. Related Work. Other sections directly related to work covered in this section are the Pipeline Pressure and Leakage Testing section and pipeline specifications.

1-2.03. Governing Standard. All disinfection work shall conform to the requirements of ANSI/AWWA C651, and the requirements of California Division of Drinking Water, except as modified herein. If any state or local requirements conflict with the provisions of this section, the state and local requirements shall govern.

Contractor shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of neutralized or diluted chlorinated water from the final flushing of pipelines and to identify acceptable locations for disposal of the flushing water. All requirements and

costs associated with notification and obtaining any discharge permits shall be the responsibility of the Contractor.

1-2.04. Experience. The disinfection work shall be performed by a subcontractor specialized in such work, or with the permission of Engineer, Contractor may provide the necessary equipment and do the work with his own personnel. In either case, all work shall be done under the direct supervision of a competent and experienced specialist in such work.

Personnel performing the disinfection shall demonstrate a minimum of 5 years experience in the chlorination and dechlorination of similar pipelines.

1-3. SUBMITTALS.

1-3.01. Cleaning and Disinfection Plan. Unless otherwise specified, Contractor shall submit a detailed cleaning and disinfection plan to Engineer 14 days prior to starting any cleaning and disinfection work. The plan shall cover the method and procedure proposed, necessary coordination, qualification of personnel performing the disinfection work, sequence of operations, the limits of the pipelines to be cleaned and disinfected, the positions of all valves, location of temporary bulkheads, materials and quantities of each to be used, equipment to be used, manner of filling and flushing the pipelines, chlorine injection points, sample points, bacteriological testing location and schedule, potable water source, method of metering the water if required, neutralization and disposal of wasted water, and all other methods and procedures to be followed in performing the cleaning and disinfection work.

1-3.02. Testing. Bacteriological testing shall be performed by an independent testing laboratory furnished by Design-Builder. Design-Builder shall submit the qualifications of the proposed independent testing laboratoryfor State approval to performing the specified bacteriological tests. Upon completion of each test, three copies of the test results shall be documented.

Contractor shall provide all items of equipment, piping, and other facilities necessary to assist with the collection of the samples as required. Locations for bacteriological sampling shall be in accordance with the governing standards or as acceptable to the Owner.

The chlorine residual tests shall be performed by Contractor. The test logbook shall be made available to Owner or Engineer upon request and shall be submitted to Engineer upon completion of all chlorine residual testing.

1-4. QUALITY ASSURANCE.

1-4.01. Chlorine Residual Tests. Contractor shall provide the necessary apparatus for making the chlorine residual tests by the drop dilution method in

Appendix A of ANSI/AWWA C651. Test results shall be recorded in a logbook that includes for each test: the location, date, time, test results, and test kit manufacturer.

1-4.02. Bacteriological Tests. Sampling and testing of water in the pipelines shall be performed after final flushing in accordance with Section 5 of ANSI/AWWA C651. Two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected and standard heterotrophic plate counts measured for each sample.

1-4.03. Redisinfection. Should the bacteriological tests indicate the presence of coliform organisms at any sampling point, the pipelines shall be reflushed, resampled and retested in accordance with Section 5 of ANSI/AWWA C651. If check samples show the presence of coliform organisms, then the pipelines shall be rechlorinated until acceptable results are obtained.

PART 2 - PRODUCTS

2-1. MATERIALS. All materials furnished by Contractor shall conform to the requirements of ANSI/AWWA C651 and shall be clean and free of debris which could infer questionable test results.

2-1.01. Liquid Chlorine. Liquid chlorine shall conform to AWWA B301.

2-1.02. Calcium Hypochlorite (Dry). Calcium hypochlorite shall conform to AWWA B300.

2-1.03. Sodium Hypochlorite (Solution). Sodium hypochlorite shall conform to AWWA B300.

2-1.04. Chlorine Residual Test Kit. Chlorine residual concentration shall be measured using an appropriate range, drop count titration kit or an orthotolidine indicator comparator with wide range color discs. The color disc range shall be selected to match chlorine concentration limits. Test kits shall be maintained in good working order and available for immediate test of residuals at point of sampling. Test kits manufactured by Hach Chemical or Orbeco-Hellige are acceptable.

PART 3 - EXECUTION

3-1. APPLICATION.

3-1.01. Cleaning. Pipelines, including all associated valves and fittings, shall be cleaned.

Small pipelines shall be cleaned by flushing with water at the maximum velocity which can be developed, but not less than 2.5 feet per second. Flushing shall continue until the pipeline is free of dirt, debris, and other foreign materials. Cleaning shall precede disinfection.

Large pipelines may be flushed as specified for small pipelines, cleaned with a hose, or cleaned by other methods proposed and approved by Design-Builder. Flushing or other cleaning methods shall continue until the pipeline is free of dirt, debris, and other foreign materials. Cleaning shall precede disinfection.

Flushing shall be accomplished through the installed valves or fittings, blow-offs or through temporary flushing connections installed for that purpose.

Booster pumps shall be used if needed to obtain the necessary volume or velocity of water. Pumping equipment installed under this Contract shall not be used for flushing, nor shall the flushing water be passed through them or other installed equipment; temporary bypass piping at each pump or installed equipment shall be provided as needed.

3-1.02. Disinfection Procedure. The pipelines shall be disinfected by the tablet method, continuous feed method, or slug method. Potable water shall be used in conjunction with the chlorination agent.

For the continuous feed or slug method, the chlorination agent shall be injected into the line at the supply end of each new pipeline or valved section thereof.

Admission of disinfectant solution into or the flushing thereof through existing piping shall be held to the minimum possible, and then only after adequate measures have been taken to prevent any such solution of chlorinated wastewater from entering branch service connections to water customers or other piping systems.

During disinfection, all valves and hydrants shall be operated to ensure that all appurtenances are disinfected. Valves shall be operated such that the chlorine solution in the pipeline being chlorinated will not flow back into the supply line. Check valves shall be used if needed.

Existing pipelines which may become contaminated during work requiring connections to the new pipeline, involving either tapping or cutting into operations, shall be flushed and disinfected in accordance with Section 4 of ANSI/AWWA C651.

3-1.03. Final Flushing. Upon completion of chlorination, but before sampling and bacteriological testing, all heavily chlorinated water shall be removed from the lines by flushing with potable water until the chlorine residual in the lines is

not higher than that generally prevailing in the adjacent existing system or as acceptable to the Owner's Representative.

Final flushing shall be accomplished as specified for cleaning of pipelines.

3-1.04. Disposal of Chlorinated Wastewater. All chlorinated wastewater to be discharged shall be neutralized by chemical treatment and disposed in accordance with Section 4 and Appendix C of ANSI/AWWA C651 and the requirements of the governing agency specified herein. Schedule, rates of flow, and locations of discharge of disinfection and flushing water shall be coordinated with Engineer and in accordance with all applicable rules and regulations.

End of Section

Section 33 16 13.13

STEEL WATER STORAGE RESERVOIR

PART 1 - GENERAL

1-1. SCOPE. This section covers the design, fabrication, construction, installation, and testing of a water storage reservoir as indicated herein. The bolted steel water storage reservoir shall be erected on and anchored to a reinforced concrete ring-type foundation as specified and as indicated on the Drawings and the Tank Datasheet.

Reservoir designation.	Product Water Tank
Number of units.	1
Reservoir tag numbers.	TW-1-001
Reservoir location.	Area 62

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions and recommendations of the tank manufacturer unless exceptions are noted by the Owner.

Refer to the Tank Datasheet for the minimum information required to define the bolted steel tank system process requirements. All uncoated wetted process equipment materials shall be 316L Stainless Steel unless otherwise specified in the bid documents or unless the Supplier design stipulates another material for technical reasons. The materials on all internal components that are in contact with the product water shall comply with NSF Standard No. 61.

1-2.01. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.02. Governing Standards. Except as otherwise specified herein, all work both in the shop and in the field shall be in accordance with applicable requirements of the latest edition of ANSI/AWWA D103, D104, and C652.

1-2.03. Cleanliness. All erection operations shall be conducted in a clean and sanitary manner.

1-3. SUBMITTALS.

1-3.01. Tank and Foundation Design. Design drawings and a listing of design criteria used for the design, that are signed and sealed by a Civil or Structural Professional Engineer registered in the state of California, shall be submitted to the Design-Builder for review. The tank supplier shall have a Professional Engineer licensed in the State of California to calculate the sloshing depth per AWWA D103-09 Section 14 and include the calculations in their submittal.

1-3.02. Pipe Support Design. Design drawings and a listing of design criteria, including seismic and buoyancy for all pipe supports inside reservoir and attached to exterior reservoir wall, signed and sealed by a Civil or Structural Professional Engineer registered in the State of California.

1-3.03. Fabrication Details. Complete fabrication drawings and specifications covering materials to be furnished, dimensions, sizes and thicknesses of plates and members, details of welded joints and nozzles, fabrication and erection of steel work, ringwall, and all accessories. All horizontal and vertical loadings, anchor bolt sizes and locations, and maximum loads imparted to the foundation shall be included.

1-3.04. Capacity of Reservoir. Data shall include a table showing capacity of the reservoir in gallons at all levels from empty to full for each 0.10-foot variation in water depth.

1-3.05. Test Reports. Certified mill test reports for steel plate.

1-3.06. Bolting Procedures and Inspections. Storage will be tested after tank erection. Seams in floor plates shall be vacuum tested. Shell shall be tested by filling with water to elevation of overflow. Completed storage tanks shall show no leaks at the end of a 24-hour test period.

1-3.07. Disinfection Procedures. Written procedures for disinfection of the reservoir.

1-3.08. Seismic Design Requirements. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.09. Certification Compliance. Submittals shall include certification that each applicable Section of AWWA D103 is met. Any exceptions taken shall be noted with full explanation given for the deviation.

1-3.10. Operation and Maintenance Manual. Provide a standard Operation and Maintenance Manual upon approval of the drawings and completion of the tank installation.

1-4. FABRICATION REQUIREMENTS.

1-4.01. Tank Manufacturer's Qualifications. All work in connection with fabrication and erection of the steel water storage reservoir shall be performed by a competent and experienced tank manufacturer. All design drawings and design criteria shall be signed and sealed by a Civil/Structural Professional Engineer registered in the State of California.

Provide a copy of Builder Certification Program sponsored by the tank manufacturer certifying factory training and experience of the proposed Builder. Documented qualifications of tank builders and project construction foreman shall be submitted for review. Foreman shall have construction experience of at least five years in bolted glass fused to steel construction and at least (3) specific tank projects that are fully complete. Construction experience shall be for tanks of similar size as to the one specified herein. Owner reserves the right to reject without penalty proposed foreman that does not meet the prior experience requirements.

1-4.02. Workmanship and Materials. Tank manufacturer shall guarantee the tank against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure for a period of at least two (2) years.

1-4.03. Field Erection. Field erection of glass lined bolted steel tanks will be in compliance with manufacturer's recommendations and performed by the manufacturer's employees or certified erection crew to alleviate any potential disputes in coating quality of erection thereof.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Each reservoir shall meet the performance and design requirements as indicated in the Tank Datasheet.

2-2. CONSTRUCTION. Each glass-lined, bolted steel water storage reservoir shall have an aluminum geodesic dome-shaped roof and shall be free standing. Tanks shall be manufactured by California Aquastore-CST, Engineering America, or approved equal.

2-3. MATERIALS AND DESIGN. Materials shall conform to the requirements of ANSI/AWWA D103-09, and structural design shall be in accordance with ANSI/AWWA D103-09, with the following exceptions.

a. Design Basis. Design basis shall be the following:

Section 14 designs will not be acceptable.

b. Section 3.9 - Corrosion Allowance. Per Tank Datasheet.

c. Section 3.10 - Minimum Thickness. Except where otherwise specified, the minimum metal thickness for any part of the structure shall be the greatest of the following:

(1) Design thickness.

(2) Thickness specified in Section 3.10 of ANSI/AWWA D103-09

(3) 1/4 inch.

Whenever there is a change in thickness greater than 1/16 inch in sidewall plates, the plates shall be joined so that the offset is on the inside and the outside face is flush.

Structural design shall also be in accordance with ASCE 7, and the more critical values from ASCE 7 and ANSI/AWWA D103 shall govern the design. Loading criteria for the ASCE 7 design shall be in accordance with the Meteorological and Seismic Design Criteria section.

2-3.01. Tank Foundation. The tank foundation shall be designed by a professional engineer registered in the State of California.

The foundation design and details shall take into account the recommendations in the Geotechnical Report. The Design-Builder is responsible for obtaining any additional information required for the foundation design. Subsurface and physical conditions reports are available per the Geotechnical Report.

The tank wall shall be supported on and bolted to a reinforced concrete ringwall (ring foundation) as indicated in the Tank Datasheet. The reinforced concrete ring foundation shall be sized to resist uplift forces at anchor bolts.

Sliding stability of the tank due to seismic loading shall be considered. Lateral loads imposed on the tank by an earthquake or other transient loading will be resisted by the passive resistance of the adjacent soil/fill acting on the sides of the footings and by sliding frictional forces.

Concrete, reinforcement, and associated work shall be in accordance with the Cast-in Place Concrete section.

2-3.02. Tank Floor. Tank floor shall be glass coated bolted steel.

2-4. COATING. Coating shall conform to the applicable paragraphs of ANSI/AWWA D103-09 and to supplementary requirements stipulated herein.

2-4.01. Glass Lining. The glass lining system shall be in accordance with the requirements of AWWA D103, latest revision. Coating frits shall be individually tested in accordance with PE1 Test T-2. (Citric acid at room temperature) When glass fused-to-steel coatings are specifed, the coatings shall be applied according to the tank manufacturer's specifc procedure. The glass coating system shall comply with NSF Standard No. 61.

2-4.02. Surface Preparation. Following the de-coiling and shearing process, sheets shall be steel grit blasted on both sides to the equivalent of SSPC SP-10 (near white metal blast cleaning). Sandblasting and chemical pickling of steel sheets is not acceptable. The surface anchor pattern shall be not be less than 1.0 mils. (.001inches). Sheets shall be evenly oiled on both sides to protect them from corrosion during fabrication.

2-4.03. Cleaning. After fabrication and prior to application of the coating system, all sheets shall be thoroughly cleaned by caustic wash and hot water rinse followed immediately by hot air drying. Inspection of the sheets shall be made for traces of foreign matter, soil particles, grease or rust. Any such sheets shall be re-cleaned or grit-blasted to an acceptable level of quality.

2-4.04. Coating Application. All steel sheets shall be primed with catalytic nickel oxide glass.

Glass coatings to be applied by wet spraying. Coatings shall be fused to steel by firing in high temperature range of 1450°F - 1600°F.

The standard tank sidewall finished outside color shall be grey. Color samples shall be provided to the Owner for approval prior to coating of the steel plates. Finished outside colors shall not vary noticeably among tank panels.

2-4.05. Coating Inspection and Testing. The manufacturers quality system shall be ISO 9001 certified and refer to ISO for the following testing and procedures. Coated sheets shall be inspected for mil thickness using an electronic dry film thickness gage with a valid calibration record. Test frequency shall be a minimum of every gage change and/or a minimum of every half hour.

Adherence of the glass coating to the tank steel shall be tested in accordance with ISO standards. Any sheet that has poor adherence will be rejected.

The tank manufacturer shall provide test documentation upon request, including mill reports and traceable documents to demonstrate the source of steel used in the manufacture of this project specific tank.

2-5. ACCESSORIES. Accessories shall conform to the applicable paragraphs of Section 7 of ANSI/AWWA D103-09 and to supplementary requirements stipulated herein.

2-5.01. Shell Manholes. Two 24-inch inside diameter manhole shall be provided in the sidewall of the reservoir approximately 3 feet above the bottom. Manholes shall provide a watertight seal. Each manhole shall be hinged to swing in. Each opening shall be suitably reinforced.

2-5.02. Pipe Connections. The pipe connections shall be as indicated on the Drawings and shall be furnished with the tank. The pipe connections shall be extended 12 inches from the tank. Steel pipe for connections shall be at least 1/4 inch thick. Suitable reinforcement shall be provided around each pipe connection.

2-5.03. Overflow. The tank shall be provided an overflow assembly shall be provided as indicated in the Tank Datasheet.

2-5.04. Inlet/Outlet Pipe. The inlet/outlet pipe shall project through the tank sidewall as indicated near the bottom of the tank. Inlet/Outlet piping shall be steel per ANSI/AWWA C200, and epoxy lined and coated per ANSI/AWWA C210 or C213. Suitable pipe connection reinforcement and pipe supports shall be provided. All interior piping and fittings shall be designed to be removable. Insulating flange unions with Type 304 stainless steel bolt kits shall be provided for all flange connections.

2-5.05. Tank Ladder. An outside tank ladder with accessories, conforming to the latest OSHA and CalOSHA requirements, shall be provided for the tank. Furnish and install a fall protection system with the ladder per the requirements of the latest CalOSHA standards.

2-5.06. Vent. Vents shall be provided as indicated in the Tank Datasheet.

2-5.07. Level Element Pipe Support. A pressure transmitter level sensor shall be mounted on the outet side near the tank bottom as shown on the Drawings.

2-5.08. Level Switches. A low and high pressure transmitter level switch shall be mounted on the outet side near the tank bottom as shown on the Drawings

2-5.09. Cathodic Protection Openings. An access opening with removable gasketed cover shall be provided in the reservoir roof adjacent to each anode or reference cell suspension insulator to permit easy anode removal through the reservoir roof without removal of supports. Similar openings shall be provided for potential measurement. The potential measurement openings shall be provided in the quantity and locations recommended by the cathodic protection system manufacturer; but not less than eight openings spaced at equal distances along the outer anode ring and two in each quadrant located where the highest and lowest structure-to-water potentials are expected in that quadrant. The cathodic protection system shall be included in the tank warranty.

2-5.10. Tether Points. A minimum of three tether points shall be provided on the tank roof near the top opening and as indicated on the Drawings.

2-5.11. Certification Plate. A stainless steel certification plate shall be installed on the side of the reservoir. The nameplates shall be of white phenolic material with black engraved lettering 3 inches high, and shall be mounted on the tank straight shell. The liquid name and the tank tag number indicated on the Tank Datasheet shall be engraved on the nameplate.

A stainless steel certification plate shall be mounted a maximum of four feet above the tank bottom on the side of each storage tank. Bracketed flat surfaces shall be provided on the tank for installation of nameplate and certification plate.At a minimum, the following data shall be included on the certification plate.

Name of tank manufacturer.

Date of manufacture.

Manufacturer's serial number.

Resin designation for entire tank (structural and corrosion barrier).

Maximum allowable concentration and temperature of the specified chemical solution that can be stored safely.

PART 3 - EXECUTION

3-1. PERIMETER SEAL. A continuous perimeter seal of 1 inch thick grout or 1/2 inch shall be provided between the top of the concrete ringwall foundation and the underside of the reservoir in accordance with Section 13.4.1 of ANSI/AWWA D103.

3-2. TANK ERECTION. The tank and its appurtenances shall be fabricated from a minimum number of pieces, and longitudinal and circumferential shell seams shall be staggered. All flange faces shall be true to the centerline of the nozzles, and bolt holes shall straddle center lines unless noted elsewhere.

3-2.01. Bottom Section. After the reservoir bottom has been completely welded and the bottom ring attached, all bolted seams shall be vacuum tested. All leaks shall be repaired.

3-2.02. Water Test. After completion of field fabrication and erection, but before field coating, the reservoir shall be filled with water to check watertightness. Any leaks discovered after the reservoir is filled shall be repaired at the expense of the Design-Builder by emptying the reservoir, fixing defective bolted seams, and

refilling the reservoir. No repair work shall be done unless the water is at least 2 feetbelow the point being repaired.

The water for testing shall be both supplied and disposed of by the Owner. All blind flanges required for this water test are by the Design-Builder. The Design-Builder shall coordinate with the Owner regarding the restrictions around supply such as pressure, flow rate, and availability. The water shall not sit in the tank, piping or equipment for more than one to two weeks if it is mixed and chlorinated as needed to keep it from going septic.

3-3. DISINFECTION. Disinfection shall be performed by Design-Builder as specified herein based on the following procedure.

After all other work, including testing and coating, has been completed, the interior of the reservoir shall be thoroughly cleaned and disinfected in accordance with ANSI/AWWA C652 Standard for Disinfection of Water-Storage Facilities except as modified herein.

Prior to starting any disinfection work, Design-Builder shall submit to Owner a detailed outline of the proposed procedures, the coordination and sequence of operations, and the manner of filling and flushing the reservoir. All procedures shall be acceptable to Owner. The Design-Builder shall flush the piping and tank, and thoroughly clean the tank prior to disinfection.

Design-Builder shall furnish all cleaning and disinfecting materials and all equipment and labor necessary for the cleaning and disinfecting operations.

All water used in cleaning and disinfecting the reservoir, and which is to be wasted, shall be disposed of in a manner acceptable to Owner and the appropriate pollution control agency.

Design-Builder shall bid and perform one of the following methods of disinfection:

Disinfection procedures shall be in accordance with Method 3 (Section 4.3.3) of ANSI/AWWA C652. Water containing 50 mg/L available chlorine shall be placed in the reservoir to fill approximately 5 percent of the total storage volume. Chlorine shall be added to the disinfecting solution as hypochlorite. The disinfecting solution shall be held in the reservoir for not less than 6 hours, the reservoir then filled to the overflow level with potable water, and allowed to stand for 24 hours. If a chlorine residual of at least 2 mg/L remains, the disinfection is satisfactory. If the chlorine residual is less than 2 mg/L, additional hypochlorite shall be added, the reservoir shall be allowed to stand for an additional 24 hours, and the chlorine residual shall be rechecked. After the disinfection is satisfactory, all highly chlorinated water shall be purged from the drain piping, and the reservoir may be placed in service. The Design-Builder shall provide

sampling data to the Owner for review and approval prior to placing the reservoir into service.

Disinfection procedures shall be in accordance with Method 2 (Section 4.3.2) of ANSI/AWWA C652. A water solution containing 200 mg/L of chlorine shall be sprayed or brushed on all interior surfaces of the reservoir. The disinfecting solution shall be prepared by adding 1 ounce [28 g] of calcium hypochlorite powder (70 percent) or 4.5 liquid ounces [133 mL] of sodium hypochlorite solution (12.5 percent) to each 26 gallons [98 L] of water. The surfaces to be disinfected shall remain in contact with the strong chlorine solution for at least 30 minutes, after which potable water shall be admitted, the drain piping shall be purged of all highly chlorinated water, and the reservoir shall be filled to the overflow level. The full reservoir shall be allowed to stand for 8 hours, after which, if a chlorine residual of at least 1 mg/L remains, the disinfection is satisfactory. If the chlorine residual is less than 1 mg/L, additional hypochlorite shall be added, the reservoir shall be allowed to stand for an additional 8 hours, and the chlorine residual shall be rechecked. After the disinfection is satisfactory, the reservoir may be placed in service. The Design-Builder shall provide sampling data to the Owner for review and approval prior to placing the reservoir into service.

Disinfection procedures shall be in accordance with Method 1 (Section 4.3.1) of ANSI/AWWA C652. The reservoir shall be filled to the overflow level with potable water containing sufficient chlorine to provide a free chlorine residual of not less than 10 mg/L after 24 hours. Chlorine shall be added as hypochlorite, as early during the filling operation as possible. If, after 24 hours, the chlorine residual is less than 10 mg/L, additional hypochlorite shall be added, the reservoir shall be allowed to stand for an additional 24 hours, and the chlorine residual shall be rechecked. After the disinfection is satisfactory, the chlorine residual in the reservoir shall be reduced to not more than 2 ppm [2 mg/L] nor less than 1 ppm [1 mg/L] by wasting the contents and refilling with potable water or by reducing the contents and blending with potable water. The reservoir may then be placed in service. The Design-Builder shall provide sampling data to the Owner for review and approval prior to placing the reservoir into service.

3-4. DISPOSAL OF CHLORINATED WASTEWATER. All chlorinated wastewater to be discharged shall be neutralized by chemical treatment and disposed of in accordance with ANSI/AWWA C652, Appendix B.

Design-Builder shall schedule and coordinate rates of flow and locations of discharge of neutralized disinfection and flushing water with Owner and regulatory agencies to ensure compliance with all applicable rules and regulations. Discharge of construction waste is regulated by the Regional Water Quality Control Board under the National Pollutant Discharge Elimination System (NPDES). Contractor shall be responsible for following NPDES requirements for construction waste discharge.

3-5. STARTUP AND TESTING. Refer to the Startup and Testing Section for additional testing requirements. Tests shall include, but are not limited to, verifying all electrical, mechanical, instrumentation and communications systems that are installed at the tank site.

End of Section

Section 33 16 13.13 - DATASHEET

STEEL WATER STORAGE RESERVOIR

Scope	
1	This Datasheet is applicable to bolted steel tanks.
General Requirements	
2	The Supplier shall furnish all materials, equipment, accessories, erection, and testing services as specified in this specification datasheet and the Steel Water Storage Reservoir Specification Section.
3	Steel Water Storage Reservoir shall be furnished and erected as specified herein. General arrangement of the tanks, including locations of piping, accessories, and other appurtenances, shall be as indicated on the drawings. The numbers, locations, types, and sizes of the piping connections indicated on the drawings are approximate and subject to change later by the Purchaser.
4	The tank shall be a vertical, cylindrical, aboveground, atmospheric tank designed for field erection by bolting as specified on the Steel Water Storage Reservoir Specification Sheet(s).
5	Each tank shall be designed for installation on a foundation designed by the steel tank supplier. Foundations will be Type 1 or Type 2 as defined elsewhere in this datasheet and as indicated on the Steel Water Storage Reservoir Specification
Design Criteria	
6	Work performed under these specifications shall be done in accordance with the codes and standards defined on the Steel Water Storage Reservoir Specifications Section. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply. These references shall govern the work except where they conflict with the Purchaser's specifications. In case of conflict, the latter shall govern to the extent of such difference.
7	The thicknesses of the tank roof, shell, and bottom plates shall be as required by code, plus corrosion allowance(s) if specified in the Steel Water Storage Reservoir Specification Section.
8	Seismic and wind design shall be in accordance with the Meteorological and Seismic Design Criteria section.
9	Design pressure for all tanks shall be atmospheric pressure.
10	Certified mill test reports that cover all steel plates and structural shapes to be used in the work shall be furnished as evidence that such materials are new and in compliance with the referenced standards.
11	Tank roof, shell, and bottom
12	For Field Erected Bolted Tanks, the tank roof shall be a self-supporting type. All shell, roof, and bottom plate joints shall be of the bolted type designed in accordance with the requirements of AWWA D103.

13	For all tank types a crowned tank bottom with a slope of 1 to 120 shall be provided.
14	All field joints shall be properly identified on the erection drawings.
15	Joint location and design shall be acceptable to the Purchaser.
Fabrication Requirements	
16	Tank sections shall be shop fabricated to the maximum extent practical to minimize field assembly.
17	Welding shall be performed in accordance with the specified design codes.
18	Exterior and interior surfaces of the plates for Field Erected Bolted Tanks shall be shop coated.
Tank Appurtenances	
19	Shell manholes
20	Provide two shell manholes as indicated on the Drawing(s). Shell manholes shall be 24 inch diameter hinged closures.
21	Manhole gaskets
22	Furnish two sets of permanent gaskets for all manhole covers. Furnish the permanent gaskets in wooden boxes identified by tank name.
23	Piping Connections
24	Provide piping connections in a table (Nozzle Schedule) as indicated on the drawings and as specified. Provide raised face, ANSI Pressure Class 150, weld neck type flanges. Prepare butt welding ends in accordance with the detail drawings. Unless otherwise indicated on the drawings, tank connections 2 inches and smaller shall be ANSI Pressure Class 3000 integrally reinforced forged branch outlet fittings. Provide each tank outlet that is larger than 4 inches in diameter with an antivortexing device.
25	Overflow
26	An internal overflow assembly shall be provided. The assembly shall consist of a rectangular overflow box mounted on the interior of the shell, with a discharge pipe that extends from the bottom shell side of the box down the exterior of the tank to near ground level. The overflow box shall span the overflow level and shall act as a weir across which water passes from the tank to the overflow box. The overflow box shall be sized as required to handle the maximum inflow rate specified. The discharge end of the overflow pipe shall be provided with a flange for connection by others 1 foot above the top of foundation elevation. Overflow piping shall be rigidly supported and braced from the tank wall at intervals not exceeding 6 feet. The piping shall be adequately supported and braced for weight, expansion or contraction, wind, and hydraulic forces. U bolts for support members shall not be used. If required, spreading pads shall be provided on the shell where pipe supports are attached.
27	Tank Vent for Field Erected Bolted
28	A gooseneck minimum 6” vent with galvanized wire bug-screen shall be furnished.

29	Grounding pads	
30	Provide four stainless steel grounding pads equally spaced around the exterior of the tank, welded to the tank shell 6 inches above the bottom. Provide pads 2 inches by 3-1/2 inches by 1/2 inch thick, drilled and tapped to full thickness for two 3/8 16 (M10 x 1.5) hex head cap screws. Match screw hole spacing and location to that of NEMA standard two-hole terminals. Provide flat and smooth contact surfaces, which should be protected during handling to maintain contact surface quality.	
Access Provisions		
31	Access provisions shall be in accordance with Section 21000 and the following	
32	Exterior Ladder. Provide an exterior ladder with tie-off fall restraint device per CalOSHA	
33	Exterior Stairs. Not Required.	
34	Interior Ladder. Not Required.	
Tank Erection Requirements		
35	Supplier shall provide complete field erection of tank(s) provided under these specifications in accordance with the codes and standards defined on the Steel Water Storage Reservoir Specification Sheet(s), including but not limited to: • Receiving and storage of materials and equipment. • Erection, assembly, and construction services. • Testing. • Glass lining, painting and coating. • Correction of any defects, design or construction errors to the satisfaction of the Purchaser.	
36	Shop fabricated tank sections and structural components shall be handled during shipping, storage, and erection in a manner that will prevent warping, bending, distortion, or physical damage of any kind.	
37	Tank appurtenances shall be installed in accordance with referenced codes and standards and manufacturer's instructions.	
38	Tank foundation interface	
39	The tank support concrete foundation will be designed by the Supplier per the Specification Section.	
40	For Type 1 (concrete ringwall with soil infill) foundations, a layer of clean sand, finely crushed limestone, or clam shells compacted to a minimum thickness of 3 inches shall be furnished and installed by the Supplier between the earthen interior of the ring wall and the tank bottom. The clean fill material shall be kept free of topsoil, clay, organic material, and other deleterious substances. A 1 inch minimum space between the tank bottom and top of the ringwall shall be grouted full with portland cement grout. Alternatively, for self-anchored tanks with foundations meeting the level tolerances, a 1/2 inch (13 mm) thick cane-fiber joint filler in accordance with AWWA D103 may be used in lieu of the 1 inch (25 mm) of grout.	

41	For Type 2 (concrete mat or concrete ringwall with concrete infill) foundations, a sand cushion not less than 1 inch thick shall be provided between the tank bottom and the concrete slab foundation. Alternatively, a minimum 1/2 inch (13 mm) thick cane-fiber joint filler meeting the requirements of ASTM D1751 shall be furnished and installed by the Supplier between the tank bottom and concrete slab. The tank shell shall be supported with portland cement grout or, alternatively, for self- anchored tanks with foundations meeting the level tolerances, 1/2 inch thick cane-fiber joint filler in accordance with AWWA D103 may be used in lieu of the 1 inch of grout.
42	When portland cement grout is used as the bearing surface for the tank shell, it shall be installed after erection of the first shell course. Sand and water used for grouting the tank bottom shall meet the following minimum requirements: • Sand - Fine aggregate, clean, well graded, natural sand. • Water - Clean and free from mud, oil, organic matter, and other deleterious substances.
43	Grout shall be mixed and placed in accordance with the manufacturer's recommendations. Grouting for water tanks shall be mixed in the proportions specified in AWWA D103. All grout shall be thoroughly mixed for not less than 5 minutes in a mechanical mixer of an acceptable type. After mixing, the grout shall be used immediately, before stiffening sets in.
44	After complete curing of the grout, the peripheral joint between the tank bottom plate and the foundation shall be completely sealed as indicated on the seal detail included as an attachment to these specifications. A two-component polysulfide rubber sealant shall be applied in accordance with the sealant manufacturer's recommendations, including removal of oil from all surfaces in contact with the sealant.
45	Testing
46	For Field Erected Bolted Tanks, all testing shall be performed in accordance with AWWA D103 and as stated herein. Bottom joints shall be tested by the vacuum box method.
47	Each Field Erected Bolted Tank shall be filled with water after erection and before any external piping has been connected, and all submerged joints shall be inspected. Any leaking joints shall be repaired in accordance with the tank manufacturer's recommendations.
48	Nameplates
49	Each tank shall be provided with a nameplate as indicated in the Specification Section.
50	Cleaning and disinfecting
51	After erection, testing, and painting have been completed, the interior of the tank shall be thoroughly cleaned and all debris shall be removed.

52	If specified on the Specification Section, the tank interior shall be disinfected in accordance with the referenced standard and state and local laws and ordinances, whichever requirements are the most stringent. Prior to starting any cleaning and disinfecting work, the Supplier shall submit to the Purchaser the detailed procedures proposed, including the coordination and sequence of operations. All procedures shall be acceptable to the Purchaser.
Notes	
53	

Tank Name: Product Water Tank			
General			
1	Number of tanks required	1	
2	Tank identification number	TW-T-0001	
3	Tank description	Product Water Storage Tank	
4	Liquid stored	RO Product Water	
Design Requirements			
5	Net capacity, gal	200,000	
6	Density lb/ft3	62.4	
7	Maximum shell outside diameter ft	68	
8	Approximate straight side shell height ft	TBD by Tank Supplier	
9	Tank roof type		
10	Conical / Domed / Umbrella	Supplier's choice	
11	Supplier's choice of above types	Yes	
12	Corrosion Allowances in		
13	Roof plates	Supplier recommended for 50 year	
14	Shell plates	Supplier recommended for 50 year	
15	Bottom plates	Supplier recommended for 50 year	
16	Tank Foundation Type	Supplier's Choice	
17	Maximum Flow Rates gpm		
18	In	645	
19	Out	645	
20	Minimum Shell Manhole Diameter, in	24	
21	Minimum Design Metal Temperature, °F	24	
22	Disinfect tank interior after erection	Yes	
Nozzles			
Nozzle Name		**Nominal Pipe Size**	**Location**
23	Inlet: RO/UV Product Water	8"	Bottom Side
24	Outlet: To IPR and Plant Reuse Pumps	10"	Bottom Side
25	Drain	3"	Bottom Side
26	Overflow	8" (to be confirmed by Tank Supplier)	Top Side
27	Level Switch (High)	2"	Bottom Side
28	Level Switch (Low)	2"	Bottom Side
29	Level Pressure Transmitter	3"	Bottom Side
30	Vent	6"	Top

Codes and Standards		
31	Design	AWWA D103, NFPA
32	Structural steel	AISC 360
33	Grounded pad screw hole spacing and location	NEMA
34	Tank erection, testing, and coating	AWWA D103
35	Cleanliness inspection before	SSPC
36	Disinfection of tank interior	AWWA C652
37	Pipe flanges	ASME/ANSI B16.5
38	Forged steel pipe fittings	ANSI B16.11
Coatings		
39	Shop applied coating system	Yes
40	Exterior	Painted. Furnish shop two-part epoxy prime coat only. Will be field coated by others.
41	Interior	Glass lined. Manufacturer standard material meeting requirements of AWWA D103 for potable water storage.
Materials		
42	Shell plate, pipe flange covers, and manhole necks (if not seamless)	ASTM A36 or acceptable equal
43	Nozzles or seamless manhole necks	ASTM A106 Grade B
44	Structural shapes and plates	ASTM A36
45	Forged steel flanges	ASTM A105
46	Tank joint bolts	ASTM A307, ASTM A325, or API 12B galvanized in accordance with ASTM A153
47	Grounding pads	ASTM A167, Type 304
48	Overflow piping	ASTM A53, Std Wt
49	Appurtenance flange bolting and nuts	ASTM A307 Gr A or ASTM A325 Type 1 bolts with hex heads or studs; ASTM A563 Gr A hex nuts; all galvanized
50	Gaskets (manhole)	EPDM
51	Gaskets (tank joints)	Manufacturer's standard compatible with the stored liquid
52	Cement	ASTM C150, Type I

53	Sand	ASTM C33
Accessories and Options		
54	The Supplier shall provide accessories and options as follows:	
55	Internal ladder	No
56	Roof handrail system as required to access level switches and vent	Yes
57	Pressure/vacuum vents	Yes
Notes		
58		

Section 40 05 23

STAINLESS STEEL PIPE AND ALLOY PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of stainless steel pipe and alloy pipe, tubing and accessories through 24" diameter for the services as indicated herein. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1-2. SUBMITTALS.

1-2.01. Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Gasket materials shall be compatible with the joints specified herein and shall be recommended by the manufacturer for the specified field test pressures and service conditions.

All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be in written form and submitted to the Design Builder for review.

Pipe for liquid chemical service shall comply with ASME B31.3. Pipe for all other services shall comply with ASME B31.1.

1-3. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage after delivery onsite shall be in accordance with manufacturer recommendations and this section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2-1. MATERIALS. Stainless steel pipe and alloy pipe materials shall be as specified herein.

2-1.01. Material Classification SS-1. Not used.

2-1.02. Material Classification SS-2.

SS-2 – Schedule 10S with Beveled Ends. Aeration air piping. Reverse osmosis concentrate piping. 2-1/2 inch and larger.	Pipe Fittings	ASTM A312 or ASTM A778 with longitudinal seams only, TP304L, Buttwelded, ASTM A403 WP-W or A774, wrought stainless steel, grade equivalent to pipe. Fittings shall conform to ANSI/ASME B16.9, Schedule 10S with beveled ends.

2-1.03. Material Classification SS-3.

SS-3 – Schedule 10S with Beveled Ends. Engine exhaust piping. 2-1/2 inch and larger.	Pipe Fittings	ASTM A312, Grade TP304L. Buttwelded, ASTM A403, WP304L. Fittings shall conform to ANSI/ASME B16.9, Schedule 10S with beveled ends.

2-1.04. Material Classification SS-4.

SS-4 – Schedule 40S with Beveled Ends. Microfiltration filtrate piping Reverse osmosis piping per Drawings 2-1/2 inch and larger	Pipe Fittings	ASTM A312, Grade TP304L,. Buttwelded, ASTM A403, WP304L, Fittings shall conform to ANSI/ASME B16.9, Schedule 40S with beveled ends.

2-1.05. Material Classification SS-5.

SS-5 – Schedule 40S with Beveled Ends. Reverse Osmosis piping per Drawings. 2-1/2 inch and larger.	Pipe Fittings	ASTM A312, Grade TP316L. Buttwelded, ASTM A403, WP316L. Fittings shall conform to ANSI/ASME B16.9, Schedule 40S with beveled ends.

2-1.06. Material Classification SS-6.

SS-6 – Schedule 40S with Threaded Ends. Gauge piping in stainless steel piping systems (to match pipe). 2 inch and smaller.	Pipe Fittings	ASTM A312, TP316. Threaded, material to match pipe. Fittings shall conform to ANSI/ASME B16.3, Class 150.

2-1.07. Material Classification SS-7.

SS-7 – Schedule 40S with Plain Ends. Gauge piping in stainless steel piping systems. Hydrogen peroxide solution piping. 2 inch and smaller with socket welded ends.	Pipe Fittings	ASTM A312, Grade TP304L, Socket welded, ASTM A182, F304L. Fittings shall conform to ANSI/ASME B16.11, Class 3000.

2-1.08. Material Classification SS-8. Not used.

2-1.09. Material Classification SS-9.

SS-9 – SS Tubing with Compression Fittings Grease piping for grit removal equipment. Lubrication water to grit removal equipment.	Tubing	ASTM A269, seamless, TP316, annealed, max hardness Rockwell B80; with the following min wall thicknesses: Tube OD inches: 1/4 to 3/8; 1/2 to 7/8; 1 to 2 Wall Thickness inches: 0.065; 0.083; 0.109

	Fittings	Compression type, AISI Type 316 stainless steel; Crawford "Swagelok", or Parker Hannifin "CPI" or "Ferulok".

2-1.10. Material Classification SS-10. Not used.

2-1.11. Material Classification SS-11.

SS-11 – Schedule 10S with Beveled Ends. 2-1/2 inch [63 mm] and larger.	Pipe Fittings	ASTM A312 or ASTM A778 with longitudinal seams only, TP304L or TP316L, Buttwelded, ASTM A403 WP-W or A774, wrought stainless steel, grade equivalent to pipe. Fittings shall conform to ANSI/ASME B16.9, Schedule 10S with beveled ends.

2-1.12. Material Classification CRP-1.

CRP-1 – Carpenter 20-Cb3 Pipe with Socket Weld Fittings Sulfuric acid piping, except where indicated otherwise.	Welded Seamless Fittings	ASTM B464 - UNS NO8020, Schedule 40. ASTM B729 - UNS NO8020, Schedule 40. Forged Fittings, ASTM B462; Socket weld, Class 3000, ASTM B462 - UNS NO8020. The use of flanged fittings shall be limited to equipment connections.

2-1.13. Material Classification HST-1.

-1 – Hastelloy C276 - Pipe with Socket Weld Fittings Sodium hypochlorite piping, except where indicated otherwise	Pipe Seamless Fittings	ASTM B622; Hastelloy C276 ASTM B622 - UNS N10276, Schedule 40 Forged Fittings ASTM B366; Welded Fittings ASTM B366; Hastelloy C276. The use of flanged fittings shall be limited to equipment connections.

2-1.14. Material Classification SS-12.

SS-12 – Alloy 2205 Duplex stainless Schedule 10S. Reverse Osmosis Piping with high chlorides	Pipe Fittings	ASTM A790 S31803 SMLS Buttwelded A815 S31803 or Socketwelded A182 F51 Fittings shall conform to ANSI/ASME B16.9 Schedule 10S with beveled ends or B16.11.

2-1.15. Accessory Materials. Accessory materials for the stainless steel pipe systems shall be as indicated. Flanges shall be flat faced for water service and shall be raised face for air or gas service except when connecting to flat face equipment or valve flanges.

Flanges			
	SS-1, SS-2 and SS-3 Pipe Backing Flanges	Stainless steel plate, AISI Type 304 or 316 to match fittings. Provide stub ends or angle face rings with material and thickness to match fittings. The angle or radius between the angle face ring or stub end and the pipe shall match the angle or radius of the backing flange for proper seating. Flanges shall conform with ANSI/ASME B16.5, Class 150 diameter and drilling; with the following thicknesses:	
		Nominal Pipe Size inches 1/2-8 10-16 18-20 24-30 36	Flange Thickness inches 1/2 5/8 3/4 1 1-1/4
	SS-4 and SS-5 Pipe Flanges	ANSI/ASME B16.5, Class 150, AISI Type 304, 304L, 316, or 316L, to match piping.	
	SS-10 Pipe Flanges	Except where otherwise permitted or required, ANSI/AWWA C207, Class D, slip-on constructed of stainless steel plate or ANSI/ASME B16.5, Class 150, AISI Type 304, 304L, 316, or 316L, to match piping.	

	SS-11 Pipe Backing Flanges		Epoxy coated carbon steel to match fittings. Provide stub ends or angle face rings with material and thickness to match fittings. The angle or radius between the angle face ring or stub end and the pipe shall match the angle or radius of the backing flange for proper seating. Flanges shall conform with ANSI/ASME B16.5, Class 150 diameter and drilling; with the following thicknesses:	
			Nominal Pipe Size inches 1/2-8 10-16 18-20 24-30 36	Flange Thickness inches 1/2 5/8 3/4 1 1-1/4
Flange Bolts			ASTM A193 Class 2, AISI Type 304, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.	
Flange Nuts			ASTM A194, AISI Type 304, ANSI/ASME B18.2.2, heavy hex pattern. Washers shall be installed under the nuts.	
Flange Gaskets				
	Process air			
		Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces, rated for 275°F service; Garlock "IFG 5507".	
		Flat Faced Flanges	Premium Grade, EPDM, full face type, 1/8 inch thick, rated for 275°F service; Garlock "8314".	
	Chemical services		Gaskets in chemical service shall be compatible with chemical.	
	All other services		Flexitalic "Style CG", spiral wound, AISI Type 304 stainless steel, non-asbestos filler, 3/16 inch nominal thickness, with compression ring 1/8 inch thick to match required flange dimensions.	

Elbows		Except for elbows in chemical service lines 4 inches [100 mm] and smaller, elbows shall be long radius type for which the laying length is 1.5 times the pipe diameter.	
Expansion Joints			
	Process air	Expansion joints shall be the elastomeric, arched type and shall be Mercer “Type 450” with “Type 500” retaining rings and Kevlar reinforcement, or equal. The number of arches shall be as indicated on the Drawings. The connection shall be suitable for a maximum pressure of 15 psig [105 kPa gauge] and maximum temperature of 275 F [122 C]. Expansion joints shall have the following minimum ratings:	
		Number of Arches: Lateral spring rate (size 12”): Lateral movement capability (size 12”): Lateral spring rate (size 4”): Lateral movement capability (size 4”):	2 616 lbs/inch 2 inch 309 lbs/inch 2 inch
Anti-Seize Thread Lubricant			
Insulating Fittings			
	Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".	
	Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions". Shall be suitable for temperature and service.	

2-1.15.01. Branch Connections. Branch connections 2-1/2 inches and smaller shall be made with welding fittings. Welded or Threaded outlets shall be used. Where the exact outlet size desired is in doubt, but is known to be less than 1 inch, a 1 inch outlet shall be provided and reducing bushings used as needed.

Branch connections sized 3 and larger shall be made with pipe nipples or with welding fittings with welded outlets. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as needed to meet design and testing

requirements. The pressure rating of branch and branch connections shall equal or exceed the pressure rating of the main pipe it is connected to.

Small branch connections shall be so located that they will not interfere with joints, supports, or other details, and shall be provided with caps or plugs to protect the threads during shipping and handling.

2-2. WELDING OF STAINLESS STEEL AND ALLOYS. Filler metal for welding austenitic stainless steel and alloys, P-number 8 base materials shall be in accordance with the following:

Material Type/Grade 304 shall use Type 308 filler metal.

Material Type/Grade 304L shall use Type 308L filler metal.

Material Type/Grade 316, shall use Type 316 filler metal.

Material Type/Grade 316L shall use Type 316L filler metal.

Material Type/Carpenter 20 shall use Carpenter 20 filler metal.

Material Type/Hastelloy C276 shall use Hastelloy C276 filler metal.

The following requirements shall apply when fabricating austenitic stainless steel and alloy components.

Grinding shall be by aluminum oxide, zirconium oxide, or silicon carbide grinding wheels that shall not have been used on carbon or low alloy steels. Hand or power wire brushing shall be by stainless steel brushes that shall not have been used on carbon or low alloy steels for stainless steel pipe. Hand or power wire brushing shall be by Carpenter 20 brushes that shall not have been used on carbon or low alloy steels for Carpenter 20 pipe. Hand or power wire brushing shall be by Hastelloy C276 brushes that shall not have been used on carbon or low alloy steels for Hastelloy C276 pipe. All tools used in fabrication shall be protected to minimize contact with steel alloys or free iron. Grinding wheels and brushes shall be identified and controlled for their use on these materials only to ensure that contamination of these materials does not occur.

Antispatter compounds, marking fluids, marking pens, tape, temperature indicating crayons, and other tools shall have a total halogen content of less than 200 parts per million.

Heat input control for welding shall be specified in the applicable WPS and shall not exceed 55,000 joules per inch (22,000 joules per cm) as determined by the following formula:

$$\text{Heat Input (J/in.)} = \frac{\text{Voltage x Amperage x 60}}{\text{Travel Speed (in./min.)}}$$

Complete penetration pressure retaining welds shall be made using the Gas Tungsten Arc Welding (GTAW) process for the root and second layer as a minimum.

Austenitic stainless steel instrument tubing shall be welded using only the GTAW process.

Socket welds or butt welds in all austenitic stainless steel instrument tubing lines shall require an inert gas backing (purge) using argon during welding to avoid oxidation.

The application of heat to correct weld distortion and dimensional deviation without prior written approval from the Design-Builder is prohibited.

Unless otherwise approved in writing, the GTAW process shall require the addition of filler metal.

The maximum preheat and interpass temperature for austenitic stainless steel shall be 350° F (176° C). The minimum preheat temperature shall be 50° F (10° C).

Complete joint penetration welds welded from one side without backing, weld repairs welded from one side without backing, or weld repairs in which the base metal remaining after excavation is less than 0.1875 inch (5 mm) from being through wall, which are fabricated from austenitic stainless steel ASME P-number 8 base metal or unassigned metals with similar chemical compositions, shall have the root side of the weld purged with an argon backing gas prior to welding. Backing gas (purge) shall only be argon. The argon backing gas shall be classified as welding grade argon or shall meet Specification SFA-5.32, AWS Classification SG-A. The backing gas (purge) shall be maintained until a minimum of two layers of weld metal have been deposited.

2-3. SHOP CLEANING AND PICKLING OF STAINLESS STEEL PIPING AND WELDS. All stainless steel piping shall be thoroughly cleaned and pickled at the mill in accordance with ASTM A380.

Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication including welded areas shall either be mechanically cleaned or repickled or passivated in accordance with ASTM A380. Materials that have been contaminated with steel alloys or free iron shall not be used until all contamination is removed. When cleaning to remove steel or iron contamination is required, it shall be performed in accordance with ASTM A380, Code D requirements. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent

contamination from iron or carbon steel objects or surfaces. Particulate matter shall be removed from piping and welds. Labels shall be affixed to the piping sections to indicate shop cleaning has been performed. Welds shall be either mechanically cleaned or pickled or passivated on the exterior of the pipe.

For buried piping, at least the exterior of all welds shall be passivated.

2-4. HIGH TEMPERATURE EPOXY COATING. Not used.

2-5. INSULATING FITTINGS. In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Size, inches	System	Name/Function	Exposure	Material(s)	Specification	Test Pressure (psi)
1	MFF	Microfiltration Filtrate - MFF	O	SS-04	400523	150
3	AS	Air-Scour - Membrane Basins	O	SS-02	400523	150
4	ROC	Reverse Osmosis Concentrate- ROC	I	SS-05	400523	150
	ROF	Reverse Osmosis Feed- ROF	I	SS-05	400523	150
6	AA	Air-Aeration Process Air	O	SS-02	400523	150
		Air-Aeration Sludge Tanks	O	SS-02	400523	150
	CIPS	CIP Solution Supply	I	SS-05	400523	150
	MFF	Microfiltration Filtrate - MFF	I	SS-04	400523	150
	ROC	Reverse Osmosis Concentrate- ROC	I	SS-05	400523	150
	ROF	Reverse Osmosis Feed- ROF	I	SS-05	400523	150
8	AA	Air-Aeration Process Air	O	SS-02	400523	150
	AS	Air-Scour - Membrane Basins	O	SS-02	400523	150
	MFF	Microfiltration Filtrate - MFF	O	SS-04	400523	150
10	AA	Air-Aeration Process Air	O	SS-02	400523	150
	MFF	Microfiltration Filtrate - MFF	O	SS-04	400523	150

Section 40 05 24.43

MISCELLANEOUS STEEL PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of miscellaneous steel pipe, tubing and accessories that for pipe diameters 24 inches and smaller. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

Steel pipe for potable and non-potable water conveyance are covered in the Steel Pipe section.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

Name of Manufacturer
Type and model
Construction materials, thickness, and finishes
Pressure and temperature ratings

Supplier shall submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with manufacturer recommendations and this Section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

1-4.01. Coated Pipe. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2-1. GALVANIZED STEEL PIPE.
Galvanized steel pipe materials and service shall be as specified herein.

2-1.01. Material Classification CSG-1.

CSG-1 – Standard Weight Galvanized Steel with Threaded Fittings All pipe sleeves except where plastic sleeves are required.	Pipe Fittings	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized. Cast iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.4, Class 125.

2-1.02. Material Classification CSG-2.

CSG-2 – Standard Weight Galvanized Steel with Threaded Fittings Grease piping – pumping units. Sump pump discharge piping in interior locations except where buried. Filtrate piping, except where buried. Drain piping from equipment, except where buried.	Pipe Fittings	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized. Malleable iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type II.

2-1.03. Material Classification CSG-3.

CSG-3 – Standard Weight Galvanized Steel with Flanged Fittings. Sump pump discharge piping in interior locations except where buried.	Pipe Fittings	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized. Cast iron flanged, galvanized. Fittings shall conform to ANSI/ASME B16.1, Class 125.

2-1.04. Accessory Materials. Accessory materials for galvanized steel pipe shall be as indicated in the Steel Pipe section of the specification.

2-2. STEEL PIPE. Steel pipe materials and service shall be as specified herein.

2-2.01. Material Classification CS-1. Not used.

2-2.02. Material Classification CS-2.

CS-2 – Standard Weight Steel with Socket Welded Fittings. Natural gas piping interior locations or outdoors above grade. Sodium hydroxide solution piping, interior locations or outdoors above grade. Compressed air supply piping, 2 inch and smaller up to 250 psig, except where buried and excluding low pressure aeration process air piping. 2 inch [50 mm] and smaller.	Pipe Fittings	ASTM A53/A106, Type S, standard weight, Grade B; Plain ends. Forged steel socket welded. Fitting shall conform to ANSI B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.

2-2.03. Material Classification CS-3.

CS-3 – Standard Weight Steel with Buttwelded Fittings. Natural gas piping, buried or interior locations. Compressed air supply piping up to 250 psig, except where buried and excluding low pressure aeration process air piping. Fuel oil or diesel fuel piping in interior locations or outdoors above grade. 2-1/2 inch and larger.	Pipe Fittings	ASTM A53/A106, Type S, standard weight Grade B; Bevel ends. Buttwelded. Fitting shall conform to ANSI/ASME B16.9, standard weight.

2-2.04. Material Classification CS-4.

CS-4 – Extra Strong Steel with Threaded Fittings. Compressed air supply piping, 251-500 psig, except where buried and excluding low pressure aeration process air piping. Fuel oil or diesel fuel piping in interior locations or outdoors above grade (seal weld). 2 inch and smaller.	Pipe Fittings	ASTM A53/A106, Type S, extra strong, Grade B; Threaded ends. Forged steel, threaded. Fittings shall conform to ANSI B16.11, Class 2000 or 3000; Bonney, Crane, Ladish, or Vogt.

2-2.05. Material Classification CS-5. Not used.

2-2.06. Material Classification CS-6.

CS-6 – Extra Strong Steel with Buttwelded Fittings. Compressed air supply	Pipe Fittings	ASTM A53, Type E, extra strong, Grade B; or ASTM A106, of equivalent thickness. Bevel ends. Buttwelded. Fittings shall conform to ANSI/ASME B16.9; extra strong.

piping, 2-1/2 inches and larger, 251-500 psi except where buried and excluding low pressure aeration process air piping.	

2-2.07. Material Classification CS-7. Not used.

2-2.08. Material Classification CS-8. Not used.

2-2.09. Material Classification CS-9. Not used.

2-2.10. Material Classification CS-10. Not used.

2-2.11. Material Classification CS-11. Not used.

2-2.12. Material Classification CS-12.

CS-12 – Steel Pipe with PTFE Lining. Sulfuric acid solution piping.	Pipe and Lining	ASTM F423
	Fittings	A587, A106 Grade B, or A53.

2-2.13. Material Classification CS-13. Not used.

2-2.14. Material Classification CS-14. Not used.

2-2.15. Accessory Materials. Accessory materials for the miscellaneous steel pipe and tubing systems shall be as indicated.

Nipples		ASTM A733, seamless, extra strong (Schedule 80); "close" nipples will be permitted only by special authorization in each case.
Unions (Malleable Iron)		Fed Spec WW-U-53l, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe.
Flanges		
	Standard Weight Pipe	ANSI/ASME B16.5, Class 150, flat faced when connected to flat faced flanges; otherwise, raised face.

Extra Strong Pipe	
Chemical Gas Piping	ASTM A105, forged steel, tongue and groove flanged union type, with nonmetallic gasket; rated for a working pressure of 1,500 psi.
Other services	ANSI/ASME B16.5, Class 300, raised face.
Plastic Lined Pipe	Steel, forged or cast, diameter and drilling in accordance with ANSI/ASME B16.5, Class 150 or 300 as required.
Flange Bolts and Nuts	ASTM A193 Class 2, AISI Type 304, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. Nuts shall be ASTM A194, AISI Type 304, ANSI/ASME B18.2.2, heavy hex pattern. Washers shall be installed under the nuts and shall be of the same material as bolts and nuts.
Flange Gaskets	
For Process Air Service	
Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces, rated for 275°F service; Garlock "IFG 5507".
Flat Faced Flanges	Premium Grade, EPDM, full face, 1/8 inch thick, rated for 275°F service; Garlock "8314".
For Oil Service	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces.
For Heating Water Service	Non-asbestos inorganic fiber with nitrile binder; dimensions to suit flange contact face, 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces; Garlock

		"IFG 5500".
	For Water Service	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch thick.
	For Chemical Service	Suitable for chemical.
For Other Services		
	Flat Faced Flanges	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces.
	Raised Face Flanges	Continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch ±0.005 inch.
Grooved Couplings		
	Rigid	AWWA C606; Gustin-Bacon "No. 120 Rigid" or Victaulic "07 Zero-Flex".
	Standard	AWWA C606; Gustin-Bacon "No. 100 Standard" or Victaulic "Style 77".
Mechanical Couplings		Dresser "Style 38" or Smith-Blair "Type 411 Flexible Coupling"; without pipe stop.

Expansion Joints

	Heating water, chilled water, and other services not specified.	Flexonics "Model H Expansion Compensators" for 3 inch or smaller; Flexonics "Mid-Corr, Series MCB" with flanged ends and stainless steel bellows for 4 inch or larger. Expansion joints shall be suitable for working pressures up to 150 psig.
Material Classification		CS-14: Double wall pipe with leak detection.
	Joining	Carrier pipe shall be joined by socket welding. Containment pipe shall be joined by split sleeve of the same diameter as containment pipe with minimum 60 mil thick polyethylene jacket.
	End Seal	End seals shall be furnished at all terminal ends. The end seal shall be sealed to the containment pipe.
	Leak Detection	Microprocessor based monitoring unit, for continuous monitoring by cable of a single line for water and hydrocarbon.
	Control Panel	Modified NEMA Type 12 enclosure, with Status and Alarm Data Model "PAL-AT20C". Power supply to the unit will be 120 volt, 1 phase, 60 Hz. Unit shall be UL listed with alarm horn and shall locate leaks and not depend on battery back-up functions. System conditions shall be stored in memory in the event of power failure and shall automatically resume monitoring without reset once power is available. Monitoring unit shall be able to differentiate between water left in pipe during installation and an actual growing leak. Panel shall also be able to detect a break in sensor cable and its location.
	Cable	Cable shall be located in the interstitial

space between the carrier and containment pipe, shall detect both water and hydrocarbon, and shall be capable of being dried in place without being replaced after exposure to any fluid Type "AGW-Gold". Coaxial cable shall interface monitoring control panel with sensor cable by utilizing waterproof junction box for protecting connection.

2-3. COATINGS. Standard weight steel pipe shall not be used in buried locations. Coatings for hot piping shall be as specified.

Extra strong steel pipe shall not be used in buried locations.

All surfaces to be tape-wrapped in the shop shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils.

Shop applied coatings shall be as follows:

External Coatings

Plastic	Liberty Coating Company “Pritec" or Bredero-Shaw “Entec". The products of other manufacturers will not be acceptable.
Tape Wrap	ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils [760 µm]; Protecto Wrap "200" or Tapecoat "CT".
High temperature epoxy for aeration and process air piping	Shop or field applied high solids epoxy; suitable for protection at continuous pipe wall temperatures up to 300 F. Coating shall be abrasion resistant. The finished coating shall have a minimum total film thickness of 10 mils. The surface shall be prepared in accordance with SSPC-SP7 as a minimum unless otherwise recommended by the coating manufacturer. The coating shall be Carboline “Thermaline 450”, Ameron “Amerlock 400 with Amercoat 880

Additive", or approved equal.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

Steel Pipe Schedule
400524 S02 Above Grade

Size, inches	System	Name/Function	Material(s)	Exposure	Specification	Steel min wall thickness	Test Pressure (psi)
14	**RAS**	Return Activated Sludge	**SP**	O	**400524**	0.25	150
20	**POW**	Plant Outfall Water - POW	**SP**	O	**400524**	0.25	150
24	**ML**	Mixed Liquor	**SP**	O	**400524**	0.25	150

Miscellaneous Plastic Pipe, Tubing, and Accessories Schedule Above Grade
400532 S02

Size, inches	System	Name/Function	Material(s)	Specification	Exposure	Test Pressure (psi)
0.5	NHS	Sodium Bisulfate	CPVC-02	400532	O	125
1	ANTI	Antiscalant -RO Influent Feed Point	PE-06	400532	I	125
			PVC-02	400532	I	125
	DRN	Process Drain	CPVC-02	400532	I	150
					O	150
	MFF	Microfiltration Filtrate - MFF	PVC-02	400532	O	150
	NHS	Sodium Bisulfate	CPVC-02, P	400532	I	125
	NPW	Non-potable water	PVC-02	400532	O	150
	POLF	Polymer	PVC-02	400532	O	125
	PRW	Plant Recycled Water	PVC-02	400532	O	150
	ROP	Reverse Osmosis Permeate- ROP	PVC-02	400532	I	150
	SA	Sulfuric Acid -UV AOP Influent Feed Point	CPVC-02	400532	I	150
2	CIPS	CIP Solution Supply	CPVC-01	400532	I	150
	DRN	Process Drain	PVC-01	400532	O	150
	FA	Foul Air	PVC-01	400532	O	150
	FBW	Filtered Backwash - FBW	PVC-02	400532	O	150
	PRW	Plant Recycled Water	PVC-02	400532	O	150
	ROP	Reverse Osmosis Permeate- ROP	CPVC-02	400532	I	150
	WAS	Waste Activated Sludge -WAS	PVC-02	400532	O	150
3	CIP	Neutralization Tank Drain	CPVC-02	400532	I	150
	CIPS	CIP Solution Supply	CPVC-02	400532	I	150
	D	Process Drain	PVC-02	400532	I	150
					O	150
	POLF	Polymer	PVC-02	400532	O	125
	ROP	Reverse Osmosis Permeate- ROP	PVC-02	400532	I	150
	WAS	Waste Activated Sludge -WAS	PVC-02	400532	O	150
4	CIPR	CIP Solution Return	CPVC-02	400532	I	150
	CIPS	CIP Solution Supply	CPVC-02	400532	I	150
	FF	RO Forward Flush	PVC-02	400532	I	150
	MFF	Microfiltration Filtrate - MFF	PVC-02	400532	O	150
	OF	Overflow	CPVC-02	400532	I	150
	PCR	Reverse Osmosis Permeate	CPVC-02	400532	I	150
	ROP	Reverse Osmosis Permeate- ROP	CPVC-02	400532	I	150
			PVC-02	400532	I	150

6	**CIPR**	CIP Solution Return	**CPVC-02**	400532	**I**	150
	OF	Overflow	**PVC-02**	400532	**I**	150
	ROF	Reverse Osmosis Feed- ROF	**PVC-02**	400532	**I**	150
	WAS	Waste Activated Sludge -WAS	**PVC-02**	400532	**O**	150
8	**FA**	Foul Air	**PVC-01**	400532	**O**	150
	ROF	Reverse Osmosis Feed- ROF	**PVC-02**	400532	**I**	150
					O	150
	ROP	Reverse Osmosis Permeate- ROP	**PVC-02**	400532	**I**	150
	UVE	Ultraviolet Treatment Effluent - UVE	**PVC-02**	400532	**O**	150
10	**FA**	Foul Air	**PVC-01**	400532	**O**	150
	IPR	Indirect Potable Reuse Water - IPR	**PVC-02**	400532	**O**	150
	ROC	Reverse Osmosis Concentrate- ROC	**PVC-02**	400532	**I**	150
	ROF	RO Feed	**PVC-02**	400532	**(blank)**	150
	UVE	Ultraviolet Treatment Effluent - UVE	**PVC-02**	400532	**O**	150
12	**MFF**	Microfiltration Filtrate - MFF	**PVC-02**	400532	**O**	150
	ROF	Reverse Osmosis Feed- ROF	**PVC-02**	400532	**I**	150
					O	150
14	**FA**	Foul Air	**PVC-01**	400532	**O**	150
	ROC	Reverse Osmosis Concentrate- ROC	**PVC-02**	400532	**I**	150
18	**MFF**	Microfiltration Filtrate - MFF	**PVC-02**	400532	**O**	150

Section 40 05 51.13

VALVE INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the installation of new valves and actuators purchased by Design-Builder as part of this Work or purchased by others under the valve specifications. The equipment to be furnished by others for installation by Design-Builder is identified in the applicable valve schedules.

Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections if required.

The following specification sections are applicable to all valves to be installed on the project.

1-2. GENERAL. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer.

1-2.01. Coordination. When manufacturer's field services or installation check services are provided by the valve manufacturer, Design-Builder shall coordinate the services with the valve manufacturer.

Flanged, push-on, and grooved connections to valves including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section. Valve ends shall match piping.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3-1. INSPECTION. All valves and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Design-Builder.

3-2. INSTALLATION.

3-2.01. General. Valves shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the valve for in-place maintenance. Installation shall be in accordance with the valve manufacturer's recommendations.

Valves shall be installed and their operators oriented in such a manner that they can be operated from the main operating floors or platforms without the use of ladders or special operating devices.

Valve operators shall be accessible and access shall not be impeded by pipe, equipment, building components, etc.

Valves shall be installed such that the orientation of the operator complies with the manufacturer's recommendations.

Valve operators shall not create a hazard by extending into walkways below a minimum elevation of 7'-6" above the walkway floor.

Some drawings may indicate the dimensions of the major lines. These dimensions are subject to change to accommodate the equipment, valves, and fittings actually furnished and the variations in equipment as actually installed. If the equipment, valves, fittings, and other components of the piping systems actually furnished differ in dimensions from those indicated, the piping systems shall be altered by the Design-Builder with approval of the Engineer of Record as required to accommodate these changes. If, due to some unforeseen circumstance, the installation of the piping as indicated would result in an interference, the modifications or corrections required to install the piping free from interferences shall be made by the Subcontractor.

Valves shall be installed such that primary direction of flow through the valve matches the direction of flow as marked on the valve body or otherwise specified by the manufacturer.

Valves shall be installed in accordance with manufacturer's requirements for upstream and downstream distance from pumps, elbows and any other turbulence creating devices.

3-2.02. Installation Checks. When specified in the valve sections, the valve manufacturer will provide installation checks. For installation checks, the manufacturer's field representative will inspect the valve installation immediately following installation by Design-Builder. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

3-2.03. AWWA Butterfly Valves. Not used.

3-2.04. Check Valves.

3-2.04.01. Lift Check Valves. Horizontal lift checks shall be installed in a level horizontal position so that the internal parts rise and fall vertically, unless the valve is spring loaded. Angle pattern lift checks shall be installed in vertical pipe with flow upward from beneath the disc.

3-2.04.02. Swing Check Valves. Install valves oriented for the correct flow direction. Only valves designed for vertical installation shall be installed in vertical piping.

3-2.04.03. Low Pressure Air Service Check Valves. Dual disc wafer check valves installed in the discharge piping of centrifugal blowers shall be positioned with the valve hinge perpendicular to the impeller shaft of the blower.

3-2.05. Plug Valves.

3-2.05.01. Eccentric Plug Valves. Eccentric plug valves shall be installed with the shaft horizontal and the plug in the upper half of the valve body. Valves in horizontal wastewater, sludge, or scum lines shall be installed with the seat on the upstream end. Valves in all vertical piping shall be installed with the seat at the upper end of the valve.

3-2.05.02. Plug Valves. Not used.

3-2.06. Resilient Seated Gate Valves.

3-2.06.01. Resilient Seated Gate Valves. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendices to ANSI/AWWA C509 and C515 and with the recommendations of the manufacturer.

3-2.06.02. Double Disc Gate Valves. Not used.

3-2.07. Air Release and Combination Air Valves. The exhaust from each valve shall be piped to a suitable point. Air release valve exhaust piping leading to a trapped floor drain shall terminate at least 6 inches above the floor.

3-2.08. Hydrants.

3-2.08.01. Yard Hydrants. A concrete slab 18 inches [450 mm] square and 4 inches [100 mm] thick shall be provided around the top of each 3/4 inch [19 mm] and 1-1/2 inch [38 mm] yard hydrant. Hydrants shall be installed plumb.

Hydrant drainage shall be provided by installing below each hydrant at least 1 cubic foot [0.03 m^3] of gravel or crushed stone.

Each 4 inch [100 mm] yard hydrant shall be set on a reinforced concrete foundation at least 18 inches [450 mm] square and 6 inches [150 mm] thick. Each hydrant shall be anchored in place or adequately blocked to prevent the hydrant from blowing off the supply connection. Hydrant drainage shall be provided by installing at least 7 cubic feet [0.20 m^3] of gravel or crushed stone around the hydrant and below the top of the hydrant supply pipe.

An operating wrench shall be provided for each yard hydrant.

3-2.08.02. Fire Hydrants. Fire hydrants and yard hydrants shall be installed per the City of Morro Bay standards.

3-2.09. Valve Boxes. Valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After each valve box is placed in proper position, earth fill shall be placed and thoroughly tamped around the box.

3-3. VALVE ACTUATORS. Valve actuators and accessories shall be factory mounted on the valve, calibrated, and tested by the valve or actuator manufacturer.

3-4. FIELD QUALITY CONTROL.

3-4.01. Field Testing. After installation, all valves shall be tested in accordance with the Pipeline Pressure and Leakage Testing section.

3-4.01.01. Pressure Tests. Pressure testing shall be in accordance with the Pipeline Pressure and Leakage Testing section.

3-4.01.02. Leakage Tests. All valves shall be free from leaks.

3-5. ADJUSTING. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic and electric actuated valve.

End of Section

Section 40 05 51.16

GATE INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the installation of new gates and actuators.

The following specification sections are applicable to gates to be installed under this contract:

Open-Channel Metal Slide Gates and Weir Gates

1-2. GENERAL. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Any gates and actuators identified as being provided by others will be furnished complete for installation by Design-Builder.

1-2.01. Coordination. When installation check services are provided by the gate manufacturer, Design-Builder shall coordinate the services with the gate manufacturer. Design-Builder shall give Owner's Representative written notice at least 30 days prior to the need for manufacturer's installation check services.

PART 2 - PRODUCTS

2-1. MATERIALS. Materials shall be as follows:

Grout	As specified in the Grouting section.

PART 3 - EXECUTION

3-1. INSPECTION. All gates and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Design-Builder. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3-2. INSTALLATION.

3-2.01. General. Gates and appurtenances shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the gate for maintenance. Installation shall be in accordance with the manufacturer's recommendations and the requirements specified herein.

All bolts shall be tightened and all items requiring lubrication, including pivot pins, shall be lubricated. Anti-seize thread lubricant shall be liberally applied to the threaded portion of stainless steel anchor bolts during the installation and tightening of nuts. Excess lubricant shall be thoroughly removed following final tightening.

The threaded portion of each plastic stem cover shall be wrapped in at least two layers of teflon thread tape, and the threaded portion of steel pipe stem covers shall be coated with teflon thread sealer immediately prior to installation of the cover on the actuator.

Each gate shall be adjusted so that it does not bind or leak in excess of specified requirements. After installation, each gate shall be operated through at least two complete open-close cycles, re-adjusted and re-operated as necessary, and left in a condition acceptable to Engineer.

3-2.02. Installation Checks. When specified in the gate sections, the gate manufacturer will provide installation checks. For installation checks, the manufacturer’s field representative will inspect the gate installation immediately following installation by Design-Builder. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

3-2.03. Cast-Iron and Fabricated Stainless Steel Slide Gates. Each cast-iron and fabricated stainless steel slide gate shall be carefully installed and adjusted for proper operation. Care shall be taken to avoid warping the gate frames and to maintain tolerances between seating faces.

Wall thimbles, if required, shall be accurately positioned and supported to prevent shifting during placement of surrounding concrete. Square or rectangular thimbles shall be carefully braced both horizontally and vertically to prevent distortion.

Gates mounted directly on the vertical face of concrete walls shall be adjusted and grouted in place with non-shrinking grout in accordance with the manufacturer’s recommendations.

Gates shall be installed so that frame members and anchor bolts do not rest upon or contact steel reinforcing bars. Anchor bolts shall be set using a template.

Grout fill shall be placed in the pit in front of each flush bottom closure gate after the gate has been adjusted.

Each actuator shall be accurately set and plumbed and shall be in proper alignment with the gate and stem before the actuator is grouted in place. Operating stems shall be installed in proper alignment and shall not bind in the lift nut or stem guides.

3-2.04. Open-Channel Metal Slide Gates and Weir Gates. Each open-channel slide gate or weir gate shall be carefully installed and adjusted for proper operation. Care shall be taken to avoid deformation of the gate frames and to maintain tolerances between seating faces.

Each embedded frame shall be carefully braced in the forms before concrete is placed, or a space shall be boxed out and the frame shall be grouted in place later. Care shall be exercised to ensure that frame members and anchor bolts do not rest upon or contact steel reinforcing bars.

Components of aluminum open-channel slide gates or weir gates installed in contact with concrete, shall be coated with epoxy in accordance with the Protective Coatings section prior to installation. Damaged areas of shop-applied coatings shall be re-coated and allowed to cure before placement of concrete or grout. Anchor bolts shall be carefully set using a template.

3-3. GATE ACTUATORS. Gate actuators and accessories shall be installed in accordance with the equipment manufacturer's recommendations.

3-4. FIELD QUALITY CONTROL.

3-4.01. Field Testing. After installation, all gates shall be pressure tested for leakage at the hydrostatic heads specified. Leakage exceeding the specified limits which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Design-Builder.

3-4.01.01. Cast-Iron Slide Gates. For the maximum seating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter. For the maximum unseating heads, the leakage shall not exceed 0.2 gpm per foot of the seating perimeter.

3-4.01.02. Fabricated Stainless Steel Slide Gates. For the maximum seating and unseating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.

3-4.01.03. Open-Channel Metal Slide Gates. For the maximum seating and unseating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.

3-5. ADJUSTING. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic, or electric actuated gate.

End of Section

Section 40 05 57

VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing manual and powered valve and gate actuators and accessories as specified herein.

1-2. GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

Actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Governing Standards. Except as modified or supplemented herein, cylinder and vane type actuators shall conform to applicable requirements of ANSI/AWWA C541.

Except as modified or supplemented herein, electric motor actuators shall conform to applicable requirements of ANSI/AWWA C542.

Except as modified or supplemented herein, actuators for butterfly and eccentric plug valves shall conform to the applicable requirements of ANSI/AWWA C504.

Except as modified or supplemented herein, manual actuators for ball valves shall conform to the applicable requirements of ANSI/AWWA C507.

Except as modified or supplemented herein, actuators for cast-iron slide gates shall conform to the applicable requirements of ANSI/AWWA C560.

Except as modified or supplemented herein, actuators for open channel slide gates and weir gates shall conform to the applicable requirements of ANSI/AWWA C513.

Except as modified or supplemented herein, actuators for stainless steel slide gates shall conform to the applicable requirements of ANSI/AWWA C561.

Except as modified or supplemented herein, actuators for composite slide gates shall conform to the applicable requirements of ANSI/AWWA C563.

1-2.03. Power Supply. Power supply to electric actuators will be as indicated in the valve and gate schedules.

1-2.04. Marking. Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.

1-2.05. Temporary Number Plates. Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve or gate by number or service as indicated in the valve or gate schedule.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance with the Submittal Procedures section and the Schedule of Submittals. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.

Submittal drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.

For electric or cylinder actuators, certified copies of reports covering proof-of-design testing of the actuators as set forth in Section 5 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, together with an affidavit of compliance as indicated in Section 6.3 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, shall be submitted to Design-Builder before the actuators are shipped.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS.

2-1.01. General. Actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective valve and gate sections.

Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working

stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.

2-1.02. Valve Actuators. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential across the valve and maximum velocities through the valve where indicated in the respective valve schedules. In addition, the valve actuators shall be oversized by 20% to accommodate aging.

Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the Drawings or directed by Design-Builder.

When valves are to be buried, submerged, or installed in vaults; the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective valve schedules but not less than 20 feet.

2-1.03. Gate Actuators. Actuators shall be sized to produce the torque or thrust required to operate the gate when subject to the seating and unseating operating heads as indicated in the respective gate schedules. In addition, the gate actuators shall be oversized by 20% to accommodate aging.

Both the design head and the operating head shall be measured from the surface of the liquid to the center line of the gate.

2-1.04. Limit Switches. Limit switches shall be provided as indicated on the Drawings or in the valve and gate schedules.

For manual or cylinder type actuators, each limit switch shall be heavy duty type, with a cast NEMA Type 4 enclosure, a spring return roller lever, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts ac and 5 amperes at 125 volts dc. The switches shall be Allen Bradley "802T" or Square D "9007 Type C".

Limit switches for intelligent and standard electric actuators shall be as indicated in their respective paragraphs.

2-2. MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of the applicable governing standard(s).

2-3. VALVE MANUAL ACTUATORS.

2-3.01. General. Manual actuators of the types listed in the valve specifications or schedules shall be provided by the valve manufacturer.

Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

Actuators shall produce the required torque with a maximum pull of 80 lbs on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs on the handwheel or chainwheel or an input of 300 foot-lbs on the operating nut.

2-3.02. Handwheels. Handwheel diameters shall be at least 8 inches but not more than 24 inches for 30 inch and smaller valves and not more than 30 inches for 36 inch and larger valves.

2-3.03. Chainwheels. Unless otherwise specified in the valve schedules, all valves with center lines more than 7'-6" above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized or zinc plated carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.

2-3.04. Levers. Levers shall be capable of being locked in at least five intermediate positions between fully open and fully closed. In any building or structure containing lever operated valves, at least two operating levers shall be provided for each size and type of lever operated valve.

2-3.05. Chain Levers. Suitable actuator extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet [1.2 m] of the floor below the valve.

2-3.06. Wrench Nuts. Unless otherwise specified in the valve schedules or on the Drawings, wrench nuts shall be provided on all buried valves and on all valves that are to be operated through floor boxes. Unless otherwise directed by Owner, all wrench nuts shall comply with Section 4.4.13 of ANSI/AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

2-3.07. Operating Stands. Operating stands shall be provided in the locations indicated on the Drawings or as indicated in the valve and gate schedules. Operating stands shall support the handwheel approximately 36 inches [900 mm] above the floor. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand. When stems are 10 feet [3 m] or longer, a suitable thrust bearing shall be provided in each operating stand to carry the weight of the extension stem.

2-3.08. Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the Drawings or in the respective valve schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2-4. GATE MANUAL ACTUATORS.

2-4.01. General. Manual actuators of the types listed in the gate schedules shall be provided by the gate manufacturer. Unless otherwise specified, actuators shall conform to ANSI/AWWA C560.

All bearings and gears shall be totally enclosed in a weathertight housing having a sufficient number of fittings to permit periodic lubrication of all internal moving components without partial or total disassembly of the mechanism. The pinion shaft of crank-operated mechanisms shall be supported by roller bearings or needle bearings.

The direction of rotation of the wheel, crank, or wrench nut to open the gate shall be to the left (counterclockwise).

Actuators for rising stem self-contained gates shall be designed for mounting directly on the frame yoke.

When indicated in the gate schedules, crank-operated actuators shall be suitable for operation with a portable actuator specified herein. A suitable adapter coupling shall be furnished with each crank actuator to couple the portable actuator to the crank actuator pinion shaft as required.

2-4.02. Remote Actuators. Not used.

2-4.03. Dual Actuators. Dual actuators shall be provided where indicated in the gate schedules. Dual actuators shall be interconnected by a cross shaft complete with required couplings so both stems move at the same rate. Each cross shaft shall be protected by a full length removable aluminum or stainless steel cover attached to the yoke beam or actuator.

2-4.04. Floorstands. Floorstands shall be designed to transfer operating thrusts to the supporting structure. Each floorstand shall be designed to position the crank or the handwheel approximately 36 inches above the frame yoke, supporting surface, or adjacent operating floor or platform.

2-4.05. Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the Drawings or indicated in the respective gate schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2-4.06. Stem Covers. Rising stem manual actuators shall be provided with a stem cover as indicated in the gate schedules. Stem covers shall conform to Section 4.4 of ANSI/AWWA C560.

2-4.06.01. Plastic Covers. Covers shall be constructed of transparent plastic pipe and shall be furnished with an end cap, condensation vents, and a clear mylar position-indicating marking tape. The marking tape shall be adhesive backed and shall be permanently marked and calibrated in feet and inches [meters and millimeters]. The tape shall be applied to the stem cover after the gate has been installed and shall be so positioned that the height of the slide will be indicated by reference to the top of the stem.

2-4.06.02. Steel Covers. Covers shall be constructed from steel pipe and shall be furnished complete with a threaded end cap. All steel components of each cover shall be hot-dip galvanized following fabrication.

The operating mechanism shall be furnished with a digital or dial type mechanical position indicator. The indicator mechanism shall be installed inside a weatherproof housing and shall be clearly visible through a transparent, weatherproof window.

2-5. INTELLIGENT ELECTRIC ACTUATORS. Not used.

2-6. STANDARD ELECTRIC ACTUATORS.

2-6.01. General. Standard electric actuators as listed in the valve and gate schedules shall be provided by the valve or gate manufacturer.

Electric actuators with torque output requirements of 750 ft-lbs and less for butterfly valves and eccentric plug valves shall be quarter-turn type and shall be Auma "SGBV 05.1 through SGBV 12.1", EIM “Series P, Q, or R” or Limitorque "LY" without exception.

All other electric actuators for open-close service shall be multi-turn type and shall be Auma "SABV 07.1 through SABV 48.1", EIM “Series 2000”, Limitorque "L120", or Rotork “AWT Series” without exception.

All other electric actuators for modulating service shall be multiturn type and shall be Auma "SARBV 07.1 through SARBV 16.1", EIM “Series 2000”, Limitorque "L120", or Rotork “AWT Series” without exception.

All other electric actuators for Explosion-proof service shall be multiturn type and shall be Auma "SAExBV/SARExBV 07.1 through SAExBV/SARExBV 16.1", EIM “Series 2000”, Limitorque "L120", Rotork “AWT Series” or equal.

Each standard electric actuator shall be furnished complete with a motor, gearing, handwheel, limit switches and torque sensors, lubricants, heating elements, wiring, and terminals. Each actuator shall be constructed as a self-contained unit with a cast iron or aluminum alloy housing, of a type as indicated in the valve and gate schedules, and shall be integrally assembled on the applicable valve or gate by the valve or gate manufacturer.

Actuators shall be designed to cycle the valve or gate from the fully open to the fully closed position or the reverse in approximately 60 seconds or as indicated in the valve and gate schedules.

Actuator motors may be mounted horizontally adjacent to or vertically above the reduction gearing. All gearing shall be oil or grease lubricated.

2-6.02. Motors. Motors shall be totally enclosed, high torque design made expressly for valve and gate actuator service, capable of operating the valve or gate under full differential pressure for two complete strokes or one complete

cycle of travel without overheating. Motors shall be designed in accordance with NEMA standards and shall operate successfully at any voltage within 10 percent above or below rated voltage. Motor bearings shall be permanently lubricated. Motors for open-close service shall be rated for a minimum of 60 starts per hour and motors for modulating service shall be rated for a minimum of 1,200 starts per hour.

2-6.03. Power Gearing. Power gearing shall consist of hardened steel spur or helical gears and alloy bronze or hardened steel worm gear, all suitably lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter. Steel gears shall be hardened to at least 350 Brinell. Planetary or cycloidal gearing or aluminum, mild steel, or nonmetallic gears will not be acceptable. Gearing shall be designed to be self-locking so that actuation of a torque switch or electronic torque protection device by a torque overload condition will not allow the actuator to restart until the torque overload has been eliminated. If a secondary gear box is required, it shall be designed to withstand the locked rotor torque of the actuator.

2-6.04. Handwheel Mechanism. The handwheel shall not rotate during motor operation. During handwheel operation the motor shall not affect the actuator operation. The actuator shall be responsive to electrical power and control at all times and, when under electrical control, shall instantly disengage the handwheel. The handwheel shall rotate counterclockwise to open the valve. An arrow indicating the opening direction and the word "Open" shall be cast on the handwheel. The force required to operate the handwheel shall not exceed 80 lbs [350 N]. The handwheel shall have a padlockable declutch lever.

2-6.05. Torque Sensing. Torque and thrust loads in both closing and opening directions shall be limited by a torque sensing device. Each torque sensing device shall be provided with an adjustment setting indicator. The adjustment shall permit a variation of approximately 40 percent in torque setting. Switches shall have a rating of not less than 6 amperes at 120 volts ac and 0.5 ampere at 115 volts dc.

2-6.06. Limit Switches. Each standard electric actuator shall have a minimum of four internal limit switch assemblies which are field adjustable. Each switch assembly shall consist of at least three separate limit switches, shall be operated by the driving mechanism, and shall be independently adjustable to trip at any point at and between the fully open and fully closed valve positions. All switches shall have an inductive contact rating of not less than 15 amperes at 250 volts ac and 10 amperes at 30 volts dc with a switching load limited to 5 amperes maximum for both AC and DC.

2-6.07. Position Transmitter. When indicated in the valve and gate schedules, actuators shall be provided with an electronic type position transmitter. The transmitter output shall be an isolated 4-20 mA dc capable of driving an external

load of 0 to 400 ohms. Accuracy of the transmitted signal shall be ±2 percent of span. Repeatability and hysteresis shall be within 1 percent. The transmitter shall transmit to a remote position indicator which is specified in the Instrumentation section.

2-6.08. Heating Elements. Space heating elements shall be provided to prevent condensation in the motor and limit switch housing. Space heating elements shall not be required for actuators which are of a sealed design utilizing double O-ring seals in the motor and controls housing. Heating elements shall be rated 120 volts ac. Heaters shall be continuously energized.

2-6.09. Terminal Facilities. Terminal facilities for connection to motor leads, switches, position transmitter, and heating elements shall be provided in readily accessible terminal compartments. Each terminal compartment shall have at least two openings for external electrical conduits, one sized at least 3/4 inch [19 mm] and the other at least 1-1/4 inches. Each terminal compartment shall be large enough to allow easy routing and termination of fifteen 12 AWG conductors.

2-6.10. Controller. Each valve or gate shall be furnished with a reversing controller located inside the actuator enclosure and shall have controller devices as indicated in the valve and gate schedules. The controller shall be equipped with:

a. A motor overload protective device in each phase or solid state motor protection.

b. A space heater element, rated 120 volts ac, sized to be continuously energized for prevention of condensation within the controller enclosure.

c. A fused control power circuit taken from one power lead on the load side of the breaker and line side of the reversing starter to ground. If power supply is greater than 120 volts ac, a control power transformer with fused secondary, with volt-ampere capacity suitable for starter control plus continuous service to space heater elements in motor housing, limit switch compartment, and controller enclosure.

d. A terminal block with connectors for all external controls. All leads from the actuator motor and limit switch assembly shall be routed to terminal connections in the controller for external connections to all other control devices.

e. Auxiliary control contacts as indicated in the electrical schematics.

Reversing controllers shall be both mechanically and electrically interlocked and shall be provided with the necessary direct-operated auxiliary contacts for required interlocking and control.

Valve controllers shall be expressly selected for long life and reliable, low maintenance service under rugged service conditions.

2-6.11. Control Module. Valves or gates indicated for modulating service in the valve and gate schedules shall be provided with a control module for position modulating type service. The control module shall be mounted within the valve actuator limit switch housing. The module shall accept a standard 4-20 mA dc analog input signal with a load impedance of not greater than 400 ohms. The control module shall contain adjustments for span, zero, gain, and deadband.

The actuator shall have a slide-wire type position feedback potentiometer or electronic current position transmitter which provides a position feedback signal to the control module.

2-6.11.01. Control Performance. For any operating torque within the specified range of the valve actuator, the valve and actuator shall perform within these specified limits:

Linearity	Linearity of actual valve position as compared to demand signal shall be within ±4 percent of span over the entire operating range.
Repeatability	For any repeated demand signal to the valve actuator, the actual valve position shall be repeated.
Deadband	Deadband of the valve actuator shall be adjustable from 1 to 10 percent of span.
Hysteresis	For any repeated demand signal to the valve actuator, from either an increasing or a decreasing direction, the actual valve position shall be repeated within 1 degree of valve shaft rotation.

2-7. HYDRAULIC CYLINDER ACTUATORS. Not used.

2-8. AIR CYLINDER ACTUATORS. Provide supplier standard as required for the MBR system.

2-9. VANE TYPE PNEUMATIC ACTUATORS. This section is provided if the MBR System Supplier requires pneumatically actuated valves for their standard system.

2-9.01. General. Vane type pneumatic actuators as listed in the valve schedules shall be provided by the valve manufacturer.

2-9.02. Vane Type Pneumatic Actuators. Vane type actuators shall be sized to provide a safety factor of 25% for open-close service and 50% for modulating service, shall be designed to provide satisfactory operation using dry, oil free instrument air at 80 psig [550 kPa gauge] pressure, and shall be shop tested at 225 psig [1550 kPa gauge]. Pneumatic vane type actuators shall be as manufactured by Kinetrol, Ltd. or K-Tork International, without exception.

Actuator shaft and vane shall be a single machined part. Vane lip seals shall be constructed by the dual opposed injection molded method. Stainless steel expanders shall be fitted beneath the vane lip seals to ensure continual seal-to-case contact. All actuators shall be fitted with stainless steel threaded travel stops allowing adjustment at each end of actuator stroke.

Manufacturer shall provide all linkages, brackets, mounting accessories, and couplings required for a complete installation of the actuator to the valve. All components, except stainless steel, shall have the specified external coating.

2-9.03. Control Devices. When open-close service is specified in the respective valve schedule, a solenoid valve shall be provided to control the operation of each vane type pneumatic actuated valve. Each solenoid valve shall be a heavy-duty, single solenoid, two-position type rated for a differential operating air pressure as required. Each valve shall be designed and constructed for exceptionally long life, with forged brass body; poppet type seats and discs; continuous duty, molded, Class F coil; NEMA Type 4 solenoid enclosure; and 1/2 inch [12.7 mm] threaded conduit connection. Solenoid valves shall be rated for use with a power supply as indicated in the respective valve schedule and the air pressure specified herein, and shall be ASCO series 8344 4-way pilot operated solenoid valves with manual override features.

Each air connection on each vane type actuator shall be equipped with an adjustable flow control valve. The flow control valves and connecting piping shall be arranged to permit control of the flow rate of exhaust air from the actuator and to permit independent adjustment and control of valve opening and closing speeds. Control valves shall be sized so that the time required for the vane to complete its stroke is adjustable between 20 and 120 seconds, with an air supply pressure of 80 psig [550 kPa gauge]. Flow control valves shall be manufactured from brass or stainless steel and shall be Parker Hannifin "Colorflow F Series" or Mead "Dyla-Trol".

As an alternative to a separately mounted solenoid valve and flow control valves, actuators for open-close service may be provided with solenoid valves having integral flow controls, that are directly mounted to the actuator body. Solenoids valves shall be provided with NEMA 4 enclosures, with manual override, and 1/2 inch [12.7 mm] threaded conduit connection. Solenoid valves shall be rated for use with a power supply as indicated in the respective valve schedule and the air pressure specified herein.

An externally mounted gauge manifold with gauges shall be provided on each actuator to monitor and display air supply pressure and actuator output pressure.

Where specified for modulating service in the respective valve schedule, pneumatic vane type actuators shall be provided with an electro-pneumatic positioner provided by the actuator manufacturer. Positioner shall have an output shaft to allow direct mounting to the actuator. The positioner shall accept a 4-20 mA control signal and a nominal 80 to 100 psig air supply. Steady state air consumption shall not exceed 0.5 scfm. Linearity of the actual valve position as compared to the control signal shall be within ±0.7 percent of span. Repeatability and hysteresis of the valve position as compared to the control signal shall be ±0.7 percent of span. Positioners shall have gauges for signal pressure and positioner output pressures. Positioner enclosures shall be NEMA 4X.

Each positioner shall provide a 4-20 mA dc analog position transmitter feedback output capable of driving an external load of 0 to 500 ohms and shall be directly coupled to the actuator mechanism. Linearity shall be ±2 percent as compared to actual valve position. Repeatability and hysteresis shall be ±0.5 percent of span.

2-9.04. Single Acting-Spring Return Pneumatic Vane Type Actuators. When specified in the respective valve schedules, pneumatic vane type actuators of the single acting-spring return type shall be provided by the valve manufacturer. The actuator shall be configured such that on power failure, the spring shall drive the valve open or closed as needed. Springs shall be clock type. Each actuator shall be furnished with a 3 way solenoid valve. A flow control valve shall be furnished and installed in the solenoid valve vent.

Actuator manufacturers shall have 5 years experience with the spring return model to be provided and shall furnish references with contact information on request.

2-9.05. Actuator Assembly. Each actuator shall be factory assembled with piping and all required accessories including solenoid valve, positioner, flow control valves, and other accessories required for a properly operating system.

2-9.06. Remote Vane Type Pneumatic Actuator Control Station. Not used.

2-9.07. Extended Warranty. The pneumatic actuator manufacturer shall warrant the actuators against faulty or inadequate design, defective materials, defective workmanship, and improper assembly for a period of three years beyond Substantial Completion.

2-10. AIR-OIL CYLINDER ACTUATORS. Not used.

2-11. PORTABLE ELECTRIC ACTUATORS. Not used. 2-12. PORTABLE HYDRAULIC ACTUATORS. Not used.

2-13. ACTUATOR ACCESSORIES.

2-13.01. Extension Stems. Extension stems and stem guides shall be furnished when indicated in the respective valve schedules, indicated on the Drawings, or otherwise required for proper valve operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the actuator shaft. Extension stems shall be connected to the actuator with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.

At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet, whichever is smaller. The top stem guide shall be designed to carry the weight of the extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.

Extension stems for chemical resistant butterfly valves located in drainage sumps shall be the two-piece type with stainless steel stem, PVC housing, wall support, and collar. Unless otherwise indicated on the Drawings, the length of the stem extension shall be as necessary to position the valve operator 12 inches above the maximum liquid level in the immediate area.

Extension stems for buried valve actuators shall extend to within 6 inches of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.

Extension stems for buried valve actuators shall be provided with position indicators as specified in the valve schedules.

2-13.02. Position Indicators. Unless otherwise specified, each valve actuator shall be provided with a position indicator to display the position of the plug or disc relative to the body seat opening.

For quarter turn plug, ball, or cone type valves installed in interior locations, the indicating pointer shall be mounted on the outer end of the valve operating shaft extension and shall operate over an indicating scale on the operating mechanism cover. Where the shaft passes through the cover, a suitable stuffing box or other seal shall be provided to prevent the entrance of water.

Each actuator for butterfly valves, except where located in manholes, buried, or submerged, shall have a valve disc position indicator mounted on the end of the

valve shaft. A disc position indicator shall also be provided on each operating stand or the actuator mounted thereon.

2-13.02.01. Position Indicators for Buried Actuators. When specified in the respective valve schedules, each buried valve actuator shall be equipped with a position indicator. Position indicators shall be Indico "Model 179 Valve Position Indicators" manufactured by the Mills Engineering Company, Needham Heights, Massachusetts, or "Diviner" ground level position indicator manufactured by the Henry Pratt Company, Aurora, Illinois. Each indicator assembly shall be designed for installation on the extension stem connected to the operating stem of the buried actuator mechanism and shall be mounted in the top section of the valve box beneath the valve box cover. Each indicator shall be equipped with a wrench nut. Internal gearing shall be sealed and protected from the elements.

2-13.03. Floor Boxes. Openings through concrete slabs provided for key operation of valves shall be provided with a cast iron floor box complete with cover. The floor box shall be of the depth indicated on the Drawings. Where the operating nut is in the slab, the stem shall have a guide to maintain the nut in the center of the box; where the nut is below the slab, the opening in the bottom of the box shall accommodate the operating key.

Each floor box and cover shall be shop coated with manufacturer's standard coating.

2-13.04. Torque Tubes. Torque tube shall utilize pipe rather than solid shafting between the valve input shaft and the output shaft of the valve floorstand operator. An adjustment of 2 inches [50 mm] shall be provided in the torque tube installation. Torque tube shall be coated with the same material as the submerged valve.

2-13.05. Valve Boxes. Each valve buried to a depth of 4 feet or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches in inside diameter, shall be at least 3/16 inch [4.7 mm] thick, and shall be provided with suitable cast iron bases and covers.

Each valve buried deeper than 4 feet shall be provided with a valve box consisting of a cast iron cover and a 6 inch Cast Iron Pipe section. The cover shall be Clay & Bailey "No. 2193". The pipe shaft shall extend from the valve to 5 inches inside the valve box cover.

All parts of valve boxes, bases, and covers shall be shop coated with manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2-14. SHOP PAINTING. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable.

The following surfaces shall be painted:

Polished or Machined Surfaces	Rust-preventive compound.
Other Surfaces	Epoxy.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3-1. INSTALLATION. Actuators will be installed on the valves in accordance with the Valve Installation section and on gates in accordance with the Gate Installation section.

End of Section

Section 40 05 59.13

OPEN-CHANNEL METAL SLIDE GATES AND WEIR GATES

PART 1- GENERAL

1-1. SCOPE. This section covers furnishing slide gates and actuators as specified herein and as indicated in the Open Channel Metal Slide Gate and Weir Gate Schedule. Slide gates shall be furnished complete with frames, slides, seals, actuators, operating stems, and appurtenances as specified herein, as indicated in the schedule and as specified in the Valve and Gate Actuator section.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Gates and actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest products of a manufacturer engaged in the production of slide gates.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Governing Standard. Except as modified or supplemented herein, all slide gates shall conform to the applicable requirements of ANSI/AWWA C561 and ANSI/AWWA C562.

1-2.03. Identification. Slide gates specified herein shall be tagged as specified in the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, construction details, and specifications covering the slide gates and appurtenances shall be submitted in accordance with the Submittals Procedures section. Each drawing shall be identified with the slide gate designation.

PART 2- PRODUCTS

2-1. SERVICE CONDITIONS. The gates will isolate the BNR mixing chimney from the 2 different anoxic zones. The liquid passing over the gate is mixed liquor.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Slide gates shall be designed for the conditions and requirements indicated in the Slide Gate Schedule.

2-2.01. Design. Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fourth of the ultimate strength of each material.

Gates shall be designed for the seating and unseating heads indicated in the Slide Gate Schedule.

Gates shall be designed to fit into the structures indicated on the Drawings.

2-3. ACCEPTABLE MANUFACTURES. For slide gates acceptable manufactuers are Coldwell-Wilcox, Golden Harvest, Hydro Gate, Waterman, Fontaine, Rodney Hunt, and Whipps.

2-4. MATERIALS.

Frames, Guides, Slides, Reinforcing Members, and Yoke Beams	Stainless steel, ASTM A276, 304L or 316L and ASTM A240, 304L or 316L.
Flush Bottom Closure Seal	Compressible neoprene.
Hollow Bulb J-Seals	Compressible neoprene.
Seal Retainer Bar	Aluminum, ASTM B211 or B221, Alloy 6061-T6.
Slide Seats and Bearing Bars	UHMW polyethylene.
Operating Stems	Stainless steel, AISI Type 304 or 316.
Assembly Fasteners	Stainless steel, AISI Type 302, 303, or 304.
Epoxy Enamel	PPG-Amercoat "Amercoat 385 Epoxy", Carboline "Carboguard 890", Sherwin-Williams "Macropoxy 646" or Tnemec "Series N69 Hi-Build Epoxoline II".

2-5. CONSTRUCTION.

2-5.01. Frames. Each frame shall be an integral unit of extruded or welded structural shapes at least 1/4 inch thick. Frames shall be designed for embedment in concrete or installation on the face of concrete walls as indicated in the Slide Gate Schedule. Embedded frames shall be recessed so that the waterway is not obstructed.

Guides shall be provided on each side of each frame. Guides shall be sufficiently strong to require no further reinforcing where they extend above the operating floor, and shall support the entire height of the slide in all positions.

Full-length plastic slide seats or bearing bars shall be provided on the downstream side of the slide on gates subject to seating pressure from one direction. Gates subject to seating pressure from either direction shall be provided with plastic seats or bearing bars on both faces of the slide. Seats and bars shall be mechanically retained in the frame.

Self-contained gates shall be equipped with a yoke, shop welded to the top of vertical frame members to support the actuator. Yokes shall be fabricated from a pair of rolled or extruded channels or angles and shall be designed to deflect not more than 1/360 of the span when the gate is operated at the maximum actuator thrust with the safety factor as indicated in the governing standard. Each yoke shall be designed to permit vertical removal of the slide. Actuators shall be mounted so that no eccentric loads are transmitted to the yoke.

2-5.02. Slides. Slides shall be at least 1/4 inch [6 mm] thick and shall be provided with welded stiffeners to limit deflection to 1/360 under the maximum seating or unseating head indicated in the Slide Gate Schedule. Slides shall be adequately reinforced to withstand, without permanent distortion, the maximum thrust which can be transmitted by the operating stem. Each slide shall have a reinforced pocket or an internally threaded nut welded to the slide for connection of the stem. The pocket or nut shall be designed to withstand the maximum thrust which can be transmitted by the operating stem.

2-5.03. Closures. The bottom of each slide gate frame shall be recessed so that the waterway is not obstructed. A compressible seal shall be securely attached to the bottom of the slide or to the frame invert. The seal shall be of sufficient length to seal the bottom corners of each slide.

Where indicated in the Slide Gate Schedule, gates shall be provided with resilient hollow bulb J-seals attached to the frame members.

For weir service, slides may be lowered below the bottom of the opening. A frame member shall be provided at the bottom of the opening to seal the space between the slide and the adjacent concrete. The side guides shall be extended

below the bottom of the wall opening. A resilient hollow bulb J-seal shall be attached to the frame along the invert of the opening and up both sides to seal the slide in any positions.

Each J-seal shall be provided with a full-length retainer bar which shall compress the seal and prevent leakage between the seal and the frame member. The method of attachment of J-seals to frame members shall permit replacement of the seals without disassembling or removing the gate.

An acceptable alternative to J-seal is a UHMW polyethylene seal/seat. A UHMW polyurethane seat/seal extruded shape shall fit into a dovetail grove in the guide section, and shall seal on both upstream and downstream sides of the slide. The seat/seal system shall act as both a bearing surface and as a seal, and the seal system shall be self-adjusting. The seat/seals shall be easily replaced without removing the gate from the wall. For flush bottom application, the invert shall have a replaceable resilient neoprene seal mounted on the frame invert.

2-5.04. Operating Stems. Operating stems shall conform to the requirements of Section 4.3.6 of the governing standard. Contact surfaces of threads shall be rolled or machined to a 63 microinch finish, or smoother. Each stem shall be securely attached to the slide.

2-5.05. Stainless Steel. All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication including welded areas shall be repickled or passivated in accordance with ASTM A380 as needed to remove all traces of iron contamination. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2-6. ACTUATORS. Actuators and their accessories shall be the type as indicated in the Slide Gate Schedule and as specified in the Valve and Gate Actuator section.

Stem covers for manual actuators shall be UV resistant clear plastic, polycarbonate, or steel pipe as indicated in the Slide Gate Schedule and as specified in the Valve and Gate Actuator section.

2-7. SHOP PAINTING. All surfaces of aluminum which will be in contact with concrete, mortar, grout, or dissimilar metals shall be given a coat of epoxy enamel or coal tar epoxy.

2-8. SHOP TESTING. Gates shall be completely assembled in the shop to ensure that all parts fit together properly.

PART 3 - EXECUTION

3-1. INSTALLATION. Slide gates and appurtenances shall be installed in accordance with the Gate Installation section.

3-1.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

End of Section

Schedule 40 05 59.13-S01
Open Channel Slide Gates and Weir Gates Schedule
Manual Actuators

Tag Number	Location(1)	Nominal Size WxH (in)	Maximum Head of Water(seating) Above Invert Gate (ft)*	Maximum Head of Water(unseating) Above Invert Gate (ft)*	Invert Elevation (ft)	Operating Floor Elevation (ft)	Top of Yoke Elevation (ft)	Type of Mounting(3)	Type of Closure(4)	Dual Stems Required	Special Notations(6)	Suitable for use with an electric portable actuator	Suitable for use with a hydrauilic portable actuator	Type of Manual Actuator(7)	Limit Switches(8)	Plastic Stem Cover	Steel Stem Cover	Furnished By	Installed By	P and I DWG No.	Comments
31-BNR-G-0001	BNR	30x54	6	6	124.5	131	134	FNSC	WS	No	C	No	No	CGFS	EOT	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-001	Note gate shall open downward.
31-BNR-G-0002	BNR	30x54	6	6	124.5	131	134	FNSC	WS	No	C	No	No	CGFS	EOT	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-001	Note gate shall open downward.

Notes:

(1) Abbreviations for locations are as indicated:

AD	Aerobic Digesters
AGB	Aerated Grit Basins
BNR	BNR Basins
HW	Headworks
RSPS	Raw Sewage Pumping Station
SB	Splitter Box
SLS	Sewage Lift Station
SWDS	Storm Water Diversion Structure

(2) Abbreviations for services are as indicated:

O-C	Open - Close
M	Modulating

(3) Abbreviations for types of mountings are as indicated:

ESC	Embedded, self-contained
ENSC	Embedded, non-self-contained
FSC	Face (wall) mounted, self-contained
FNSC	Face (wall) mounted, non-self-contained

(4) Abbreviations for types of closures are as indicated:

FB	Flush bottom
FBJS	Flush bottom with hollow bulb J-seals
WS	Weir service, downward opening, with hollow bulb J-seals

(5) Abbreviations for types of electric actuators are as indicated:

IE	Intelligent Electric
IEFS	Intelligent Electric with concentric floor stand
SE	Standard Electric
SEFS	Standard Electric with concentric floor stand
D-	Prefix where dual actuators are required
-WB	Suffix where wall brackets are required

(6) Special notations and requirements are as indicated:

A Design considerations restrict the maximum travel of this gate to less than gate height; at maximum design flow, the lower portion of the gate slide may extend below the water surface when the gate is open.
B Interconnected dual actuators and dual stems are required.
C This gate may be subject to the specified seating pressure applied from either direction.
D The gate shall be provided with a rectangular port in the slide for flow regulation and shall be designed so that the slide can be raised or lowered from the indicated position.

(7) Abbreviations for types of manual actuators are as indicated:

CGBS Crank-operated, geared, benchstand
CGFS Crank-operated, geared, concentric floorstand
CGOFS Crank-operated, geared, offset floorstand
HBS Handwheel-operated, non-geared, benchstand
HFS Handwheel-operated, non-geared, concentric floorstand
HGBS Handwheel-operated, geared, benchstand
HOFS Handwheel-operated, non-geared, offset floorstand
RA Remote actuator, benchstand with side handwheel and chain drive

(8) Abbreviations for limit switches on manual operated gates.

EOT End of travel (open - close)
PSS Pump start - stop (two intermediate positions)
ELSCH See electrical schematics

(9) Abbreviations for electronic or electric actuator housing.

WP Weatherproof
SUB Submersible [xx = depth of submergence](SUBxx)
EXP Explosion proof

(10) Abbreviations for control devices are as indicated.

Table 1: Control Devices

Abbreviations	Open-Close Push Button	Open-Stop-Close Push Button	Local-Off-Remote	Red and Green Indicator Lights
A	Required		Required	Required
B	Required		Required	
C		Required	Required	Required
D		Required	Required	
E		Required		
F	Required			
G	Required			Required
H		Required		Required

END OF SCHEDULE

Section 40 05 61.23

RESILIENT-SEATED GATE VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing resilient-seated AWWA gate valves for clear water service. Resilient-seated gate valves shall be furnished complete with actuators and accessories as specified herein and as specified in the Valve and Gate Actuator section.

1-2. GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Governing Standard. Except as modified or supplemented herein, all resilient-seated gate valves shall conform to the applicable requirements of ANSI /AWWA C509.

1-2.03. Temporary Number Plates. Not used.

1-2.04. Identification. Resilient seated gate valves shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section.

All valves shall be tested in accordance with Section 5 of the governing standard. Certified copies of the results of all tests, together with an affidavit of compliance as indicated in Section 6.3 of the governing standard, shall be submitted to Engineer before the valves are shipped.

PART 2 - PRODUCTS

2-1. MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of resilient-seated gate valves shall conform to the requirements of the governing standard.

2-1.01. Bronze Components. All bronze valve components in contact with liquid shall contain less than 16 percent zinc. All aluminum bronze components in contact with liquid shall be inhibited against dealuminization in accordance with Section 4.2.3.5.4 of ANSI/AWWA C509.

2-1.02. Gaskets. Gaskets shall be free of asbestos and corrosive ingredients.

2-1.03. Shop Coatings.

Epoxy	
For Raw or Treated Water Service in potable water facilities (NSF certified systems)	PPG Amercoat "Amerlock 400 High-Solids Epoxy ", Carboline "Carboguard 891", Sherwin-Williams “Macropoxy 646NSF” or Tnemec "Series N140 Pota-Pox Plus".
For Liquid Service other than in potable water facilities	PPG Amercoat "Amerlock 385 Epoxy", Carboline "Carboguard 890", Sherwin-Williams “Macropoxy 646” or Tnemec "Series N69 Hi-Build Epoxoline II".
Rust-Preventive Compound	As recommended by manufacturer.
Universal Primer	As recommended by manufacturer

2-2. VALVE CONSTRUCTION.

2-2.01. Ends. Valve ends shall be compatible with connecting piping. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of the governing standard.

Flanges shall be finished to true plane surfaces within a tolerance limit of 5 mils [125 µm]. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per inch [0.16 mm/mm] of flange diameter.

2-2.02. Stem Seals. Valve stem shall be the non-rising type. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems.

2-2.03. Rotation. The direction of rotation of the handwheel or the wrench nut to open the valve shall be to the left (counterclockwise).

2-2.04. Shop Coatings. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. Except as specified below, the valve manufacturer's standard fusion-bonded coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating.

Surfaces shall be coated as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces of Valves to be Buried or Installed in Manholes or Valve Vaults	Epoxy.
Exterior Surfaces of Valves to be Submerged	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	
Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy.

Alternatively, the manufacturer's standard coating may be used and the interior surfaces of each valve shall be subjected to a nondestructive holiday test in accordance with ASTM G62, Method A, and shall be electrically void-free.

Interior coatings shall comply with ANSI/AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10mils [250 µm].
Universal Primer	3 mils [75 µm].

2-3. VALVE ACTUATORS. Requirements for valve actuators shall be as specified in the Valve and Gate Actuator section.

2-4. ACCESSORIES. When the Drawings indicate the need for extension stems, stem guides, position indicators, floor boxes, valve boxes, or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3-1. INSTALLATION. Valves shall be installed in accordance with Valve Installation section.

3-1.01. Installation Check. An installation check by an authorize representative of the manufacturer is not required.

End of Section

Section 40 05 61.43

KNIFE GATE VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing all Knife Gate Valves as required by the Work and as indicated in the Knife Gate Valve Schedule. Knife Gate Valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in the Valve and Gate Actuators section.

1-2. GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

Gates shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.

1.2.02. Governing Standard. The publications referred to hereinafter form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this section and the listed references, the requirements of this section shall prevail.

Reference	Title
ASME B16.5	Pipe Flanges and Flanged Fittings
MSS SP-135	High Pressure Knife Gate Valves

1-3. SUBMITTALS. In addition to the information/data required per the contract, the supplier shall provide the remaining submittals in accordance with the requirements specified herein and the Schedule of Submittals section. The Bid Submittals shall also be as detailed in the Schedule of Submittals section. The following information shall be submitted for review in accordance the Submittal Procedures section.

1. A copy of this specification section, with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.
2. Manufacturer's product data.
3. Certified factory leakage tests.
4. Spare parts listing.

PART 2 - PRODUCTS

2-1. ACCEPTABLE PRODUCTS. Knife Gate Valves shall be manufactured by DeZURIK (Hilton Valve), or approved equal.

2-2. MATERIALS. Materials used in the manufacture of Knife Gate Valves shall be as indicated:

Body	Fabricated Steel.
Bonnet	Fabricated Steel.
Wetted interior parts and fasteners	Stainless Steel, Type 316. Body cladding and face rings shall be welded to the body.
Gate	Stainless Steel, Type 316, polished to minimum surface finish of 32 micro-inch/inch RMS.
Stem and stem coupling	Stainless Steel, Type 316.
Packing gland and follower	Stainless Steel, Type 316.
Yoke	Fabricated Steel.
Resilient Seats	EPDM.

2-3. VALVE CONSTRUCTION.

2-3.01. General. Knife Gate Valves shall be bi-directional resilient seated with a pressure-retaining bonnet that fully encloses the gate. Bonnetless Knife Gate Valves are not acceptable. The bonnet shall be rated at the same pressure as the valve body and shall not include any type of internal gate packing or gate

wiper. A packing gland shall be located at the top of the bonnet to provide a tight seal around the stem.

A bevel gear operator with 2-inch nut shall be provided with each Knife Gate Valve. Operators shall be oriented on the valve yoke.

Except for the resilient seats, all wetted parts of the body and bonnet shall be 316 SS, including fasteners. Exterior flanges and stiffeners shall be cast or fabricated carbon steel.

All valves shall be capable of zero leakage shutoff in either flow direction where required and dead end isolation service with the downstream pipe flange removed.

2-3.02. Valve Body. Knife Gate Valves shall have fabricated steel bodies conforming to the general requirements of MSS SP-135. Valves shall be provided Class 125 flanges conforming to ANSI B16.1.

2-3.03. Shaft Coupling. A shaft coupling shall be provided between the valve bonnet and the top of the yoke to allow separate removal of upper portion of stem, yoke and operator prior to removal of valve from the valve vault. The yoke and shaft shall be extended as necessary to accommodate the shaft coupling while allowing normal operation from fully open to fully closed and to meet the dimensional requirements for locating the operator as shown on the drawings.

2-3.04. Seats. The resilient seats shall be EPDM, installed in a self-retaining groove that is cut into the 316 SS seat ring, and shall be replaceable without removing the valve from the pipeline.

2-3.05. Lining. The 316 body cladding and face rings shall be fully welded to the carbon steel body – “floating” body liners are not acceptable.

2-3.06. Packing. The valve bonnet shall be sealed against external leakage by Teflon impregnated synthetic fiber packing with an adjustable packing gland. The bottom of the gland shall be machined to mate with the machined stem back-seating ring, to allow the packing to be replaced with the valve pressurized. The back-seating ring shall also include a Teflon O-ring for improved sealing.

2-3.07. Gate. The gate shall be beveled and machined to evenly match the seating area in the valve body.

2-4. VALVE ACTUATORS. Requirements for valve actuators shall be as specified herein, as indicated in the Knife Gate Valve Schedule, and as specified in the Valve and Gate Actuators section. Valve actuator types shall be as indicated in the Knife Gate Valve Schedule.

Manual valves located above operator level shall be provided with chain driven operators.

2-5. OPERATING DATA. Knife Gate Valves shall be suitable for mixed liquor piping isolation, isolation of pipelines containing raw wastewater, and isolation of pipelines containing screened and degritted wastewater. They shall also be suitable for service at a minimum 130 psi service in either direction, a maximum fluid temperature of 80°F, a maximum solids concentration of 1%, and a maximum fluid velocity of 10 feet per second.

2-6. SHOP PAINTING. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable.

2-7. LUBRICATION. Valves shall be designed so that all required lubrication can be completed externally with the valve installed in the pipeline.

2-8. WELDING. All stainless steel welds exposed to the process fluid shall be pickled and passivated.

PART 3 - EXECUTION

3-1. TESTING. Valves shall be factory tested and certified for zero leakage, as follows:

1. Shell Test – Each valve body and bonnet shall be hydrostatically pressure tested at 1.5 times the rated design pressure with no visible leakage allowed (leakage through the packing shall not be cause for rejection, as long as there is no leakage at the rated design pressure). Valves shall be tested with the flanges and body unconstrained to confirm the integrity of the design.
2. Gate/Seat Test – Each valve shall be hydrostatically pressure tested at 1.1 times the maximum operating pressure in both directions of closure with no visible leakage through the gate material and with drip tight seat leakage.
3. Operational Test – Each valve shall be operated from full closed to full open and back to full closed, two times. Operation shall be smooth, with no unusual noise or vibration.

Additionally, valves shall be tested for proper alignment, balancing, and smooth operation.

3-1. INSTALLATION. Gates shall be installed in accordance with Section 15010, Valve Installation.

3-1.01. Installation Check. An installation check by an authorized representative of the manufacturer is not required.

End of Section

Schedule 40 05 61.43-S01
Knife Gate Valves Schedule
Electric Actuators

Tag Number	Size	Type of Installation	Process Code	Type of Service	Ends	Type of Electric Actuator	Type of Housing(7)	Operating Time (s)	Power for Electric Actuator	Actuator Provides 120 VAC For remote controls	Number of Limit Switch Assemblies	Position Transmitter	Control Devices(9)	Remote Control Station (11)	Extensions Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Furnished By	Installed By	P and I DWG No.
21-GRT-V-1001	18"	IP	WWS	O-C	W	HW			480v	No		No			No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
21-GRT-V-2001	18"	IP	WWS	O-C	W	HW			480v	No		No			No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-002
31-BNR-V-1001	24"	IP	ML	O-C	W	SE			480v	No		No			No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-001
31-BNR-V-2001	24"	IP	ML	O-C	W	SE			480v	No		No			No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-002
32-MEM-V-1001	24"	IP	ML	O-C	W	SE			480v	No		No			No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	32-I-001
32-MEM-V-2001	24"	IP	ML	O-C	W	SE			480v	No		No			No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	32-I-002
73-FSW-V-0001	20"	IP	FIW	O-C	W	SE			480v	No		No			No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	73-I-001

Section 40 05 62.16

ECCENTRIC PLUG VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing all eccentric plug valves as required by the Work and as indicated in the Eccentric Plug Valve Schedule. Plug valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in the Valve and Gate Actuators section.

1-2. GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.

1-2.02. Governing Standard. Except as modified or supplemented herein, all eccentric plug valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C517.

1-2.03. Marking. Each valve shall be marked with the manufacturer's name, valve size, and pressure rating, and the country of origin of the body casting. All markings shall be cast on the exterior surface of the valve body. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

1-2.04. Temporary Number Plates. Not used.

1-2.05. Identification. Eccentric plug valves shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section.

The following list of submittals shall be submitted for review:

Valve and accessory outline with overall dimensions, weights (including operators and accessories), operator removal clearance, end-to-end dimensions, direction of flow, and end connection details

Limit switches, solenoid valves, positioners, position transmitter data including make, model, electrical ratings, and physical arrangements. (Supplier only needs to submit once if components don't change from one valve to the next.)

Valve operator data, including the following: Motor operator sizing and open/close travel times, Pneumatic operator sizing and wiring diagrams

Drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Valve pneumatic tubing diagrams

Sectional drawing showing materials and internal construction

Coating and surface preparation specification

Handling, storage and installation instructions

O&M manuals

PART 2 - PRODUCTS

2-1. ACCEPTABLE PRODUCTS. Eccentric plug valves furnished under this section shall be manufactured by Victaulic, Clow, DeZurik, Pratt, Milliken, or equal.

2-2. MATERIALS. Materials used in the manufacture of eccentric plug valves shall be as indicated:

Body	Cast iron, ASTM A126, Class B; or ductile iron, ASTM A536, Grade 65-45-12.

Plug	Cast iron, ASTM A126, Class B; or ductile iron, ASTM A536, Grade 65-45-12.
Plug Facing	Chloroprene, Neoprene or Buna-N, 70 Type A durometer hardness in accordance with ASTM D2240.
Body Seat	Welded nickel overlay.
Upper and Lower Trunnion Bearings	Sleeve type; stainless steel or bronze.
Upper Thrust Bearing	TFE, Nylatron, or Delrin.
Stem Seal	V-type packing or U-cups, Buna-N or TFE.

The following are acceptable shop coatings.

Coal Tar Epoxy – for buried valves	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy	
For Liquid Service other than in potable water facilities	PPG Amercoat “Amercoat 385 Epoxy”, Carboline “Carboguard 890”, Sherwin-Williams "Macropoxy 646".or Tnemec “Series N69 Hi-Build Epoxoline II”.
For Raw or Treated Water Service in potable water facilities (NSF certified)	PPG Amercoat “Amerlock 400 High Solids Epoxy”, Carboline “Carboguard 891”, Sherwin-Williams "Macropoxy 646NSF" or Tnemec “Series N140 Pota-Pox Plus”.

2-3. VALVE CONSTRUCTION.

2-3.01. Valve Body. The valve port area of each valve shall be at least 80 percent of the cross section of the connecting piping for 20 inch and smaller valves and 70 percent for 24 inch and larger valves. Valves shall provide tight shutoff at the rated pressure from either direction. An adjustable closed position plug stop shall be provided.

Valve ends shall be compatible with connecting piping. All valves shall have flanged, grooved or mechanical joint ends as indicated in the Eccentric Plug Valve Schedule. Flange diameter and drilling shall conform to ANSI B16.1, Class 125. Flanges shall be flat faced and finished to true plane surfaces within a tolerance limit of 0.005 inch. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter. Grooved end dimensions shall conform to ANSI/AWWA C606, Table 5, for rigid joints. When grooved end valves are to be installed in flanged piping, two flange adapters compatible with the connecting piping shall be provided with each valve. Mechanical joint ends shall conform to ANSI/AWWA C111/A21.11.

2-3.02. Plug. The plug shall be of one-piece construction and shall have a cylindrical or spherical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and the body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug surfaces shall be faced with a resilient material.

2-3.03. Seats. Seats shall be cast in the body and shall have raised, welded-in nickel overlay not less than 0.050 inch thick on all surfaces in contact with the plug face. The overlay shall be at least 90 percent nickel and have a Brinell hardness of 200 or greater.

2-3.04. Stem Seals. The valve shaft shall be sealed by U-cups or by at least four self-adjusting chevron type packing rings.

2-3.05. Working Pressure. Valves shall be rated for a minimum working pressure as specified below, except where otherwise indicated in the Eccentric Plug Valve Schedule.

Size in inches(mm)	Pressure Rating in psi
3 to 12	175
14 to 72	150

2-4. VALVE ACTUATORS. Requirements for valve actuators shall be as specified herein, as indicated in the Eccentric Plug Valve Schedule, and as specified in the Valve and Gate Actuators section.

Geared actuators shall be used for manually operated valves in the following applications:

a. For all 4 inch and larger buried valves.

b. For all 8 inch and larger valves.

c. For all 6 inch and larger valves in throttling or free discharge applications.

d. For all 6 inch and larger valves where the unseating pressure exceeds 25 psi.

e. For all chainwheel operated valves.

f. For all valves in gas service.

Geared actuators for plug valves unless otherwise specified or listed in the Eccentric Plug Valve Schedule shall be rated for a differential pressure across the valve, on the seating side, of 100 psi for 6 inch to 8 inch valves, 50 psi for 10 inch and larger valves, and 25 psi for gas service valves and a maximum flow of 8 ft/s.

2-5. SHOP PAINTING. All interior and exterior ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valves and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	
For Liquid Service	Epoxy.
Exterior Surfaces of Valves to be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy or Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

Interior epoxy coatings shall comply with ANSI/AWWA C550 and shall be free of holidays.

The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Coal Tar Epoxy	15 mils
Epoxy	10 mils
Universal Primer	3 mils

2-6. ACCESSORIES. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, and valve boxes shall be as indicated in the Eccentric Plug Valve Schedule and as specified herein and as specified in the Valve and Gate Actuators section.

2-7. TESTING. Except as modified herein, eccentric plug valves shall be tested in accordance with Section 5 of the governing standard. Each valve shall be performance tested in accordance with Section 5.2 of the governing standard. The leakage test shall be applied to the seating face of the plug (tending to unseat the plug) at the rated pressure of the valve.

Each valve shall be leaktight in both directions when closed by the actuator with the maximum differential pressure applied to the plug as specified herein and in the Eccentric Plug Valve Schedule.

PART 3 - EXECUTION

3-1. INSTALLATION. Valves shall be installed in accordance with Valve Installation section.

End of Section

Schedule 40 05 62.16-S01
Eccentric Plug Valves Schedule
Manual Actuators

Tag Number	Size	Rated Working Pressure	Process Code	Application	Type of Installation(2)	Ends(3)	Maximum Differential Pressure Across Valve	High Pressure Side of Plug(5)	Type of Manual Actuator(4)	Limit Switches(6)	Extensions Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Furnished By*	Installed By	P & I DWG No.
21-GRT-V-1002	4"		WWS	RAW WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	PACKAGED HEADWORKS SUPPLIER	PACKAGED HEADWORKS SUPPLIER	21-I-001
21-GRT-V-1003	4"		WWS	RAW WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	PACKAGED HEADWORKS SUPPLIER	PACKAGED HEADWORKS SUPPLIER	21-I-001
21-GRT-V-1004	3"		WWS	RAW WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	PACKAGED HEADWORKS SUPPLIER	PACKAGED HEADWORKS SUPPLIER	21-I-001
21-GRT-V-2002	4"		WWS	RAW WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	PACKAGED HEADWORKS SUPPLIER	PACKAGED HEADWORKS SUPPLIER	21-I-002
21-GRT-V-2003	4"		WWS	RAW WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	PACKAGED HEADWORKS SUPPLIER	PACKAGED HEADWORKS SUPPLIER	21-I-002
21-GRT-V-2004	3"		WWS	RAW WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	PACKAGED HEADWORKS SUPPLIER	PACKAGED HEADWORKS SUPPLIER	21-I-002
21-SCR-V-0101	12"	175	WWR	RAW WASTEWATER	IP	F		S	HW	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
21-SCR-V-0102	12"	175	WWR	RAW WASTEWATER	IP	F		S	HW	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
21-SCR-V-0201	8"	175	WWR	RAW WASTEWATER	IP	F		S	HW	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
21-SCR-V-0202	8"	175	WWR	RAW WASTEWATER	IP	F		S	HW	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
21-SCR-V-1002	4"	175	WWS	RAW WASTEWATER	IP	F		S	HW	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
21-SCR-V-2002	4"	175	WWS	RAW WASTEWATER	IP	F		S	HW	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-002
31-SCM-V-0007	3"	175	WAS	SCUM	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0001	3"	175	WAS	WASTE ACTIVATED SLUDGE	IP	F		U	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0002	3"	175	WAS	WASTE ACTIVATED SLUDGE	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0003	3"	175	WAS	WASTE ACTIVATED SLUDGE	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0005	3"	175	WAS	WASTE ACTIVATED SLUDGE	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0011	3"	175	WAS	WASTE ACTIVATED SLUDGE	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0012	3"	175	WAS	WASTE ACTIVATED SLUDGE	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0013	3"	175	WAS	WASTE ACTIVATED SLUDGE	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
32-DRN-V-0008	6"		DRN	MIXED LIQUOR	IP	F	10	S	LVR	EOT	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-007
32-DRN-V-0009	6"		DRN	MIXED LIQUOR	IP	F	10	S	LVR	EOT	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-007
71-FBW-V-0101	6"	175	FBW	FILTER BACKWASH WASTE	IP	F	100	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-001
71-FBW-V-0201	6"	175	FBW	FILTER BACKWASH WASTE	IP	F	100	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-001
71-WAS-V-0001	3"	175	WAS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-001
71-WAS-V-0101	3"	175	WAS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-001
71-WAS-V-0102	4"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-001
71-WAS-V-0201	3"	175	WAS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-001
71-WAS-V-0202	4"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-001
72-DWT-V-0002	6"	175	WWS	SLUDGE	IP	F	100	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
72-DWT-V-0004	4"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
72-DWT-V-0007	6"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
72-DWT-V-0008	4"	175	DRN	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
72-DWT-V-0101	6"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
72-DWT-V-0108	6"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
72-DWT-V-0201	6"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
72-DWT-V-0208	6"	175	AWS	SLUDGE	IP	F	125	S	LVR	EOT	No	No	Yes	No	DESIGN-BUILDER	DESIGN-BUILDER	72-I-001
73-FSW-V-0008	6"		FIW	WASTEWATER	B4	F	125	S	HW	EOT	Yes	No	Yes	No	SAFE FILTER SYSTEM SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0009	4"		FSW	WASTEWATER	IP	F	125	S	LVR	EOT	No	No	Yes	No	SAFE FILTER SYSTEM SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0012	6"		FBW	WASTEWATER	IP	F	125	S	LVR	EOT	No	No	Yes	No	SAFE FILTER SYSTEM SUPPLIER	DESIGN-BUILDER	73-I-001
95-SAN-V-0003	4"		SAN	WASTEWATER	SV20	F		S	LVR	EOT	No	No	No	No	SANITARY LIFT STATION SYSTEM SUPPLIER	SANITARY LIFT STATION SYSTEM SUPP	95-I-001
95-SAN-V-0006	4"		SAN	WASTEWATER	SV20	F		S	LVR	EOT	No	No	No	No	SANITARY LIFT STATION SYSTEM SUPPLIER	SANITARY LIFT STATION SYSTEM SUPP	95-I-001
95-SAN-V-0009	6"	175	SAN	WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	95-I-001
95-SAN-V-0010	6"	175	SAN	WASTEWATER	IP	F		S	LVR	EOT	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	95-I-001

Schedule 40 05 62.16-S02
Eccentric Plug Valves Schedule
Electric Actuators

Tag Number	Size	Rated Working Pressure	Type of Service(1)	Process Code	Application	Type of Installation(2)	Ends(3)	Maximum Differential Pressure Across Valve	High Pressure Side of Plug(5)	Type of Electric Actuator(10)	Type of Housing(7)	Operating Time	Power for Electric Actuator Motor	Actuator Provides 120 VAC For remote controls	Number of Limit Switch Assemblies	Position Transmitter	Control Devices(8)	Remote Control Station(11)	Extensions Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Furnished By*	Installed By	P & I DWG No.
21-SCR-V-1001	16"	175	O-C	WWR	WASTEWATER	IP	F		S	SE	WP	60s	480v	No	ELSCH	No	B	CS	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
21-SCR-V-2001	16"	175	O-C	WWR	WASTEWATER	IP	F		S	SE	WP	60s	480v	No	ELSCH	No	B	CS	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	21-I-001
22-SCR-V-1001	12"	175	M	WWS	WASTEWATER	IP	F		S	SE	WP	60s	480v	No	ELSCH	No	C	CSI	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	22-I-001
22-SCR-V-2001	12"	175	M	WWS	WASTEWATER	IP	F		S	SE	WP	60s	480v	No	ELSCH	No	C	CSI	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	22-I-001
22-SCR-V-1104	14"	175	O-C	WWS	WASTEWATER	IP	F		S	SE	WP	60s	480v	No	ELSCH	No	B	CS	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	22-I-001
22-SCR-V-2003	14"	175	O-C	WWS	WASTEWATER	IP	F		S	SE	WP	60s	480v	No	ELSCH	No	B	CS	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	22-I-001
31-WAS-V-1001	6"	175	O-C	WAS	WASTE ACTIVATED SLUDGE	IP	F	5	S	SE	WP	60s	120v	No	ELSCH	No	B	CS	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-001
31-WAS-V-2001	6"	175	O-C	WAS	WASTE ACTIVATED SLUDGE	IP	F	5	S	SE	WP	60s	120v	No	ELSCH	No	B	CS	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	31-I-002
72-DWT-V-0006	6"	175	O-C	AWS	SLUDGE	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	DEWATERING SYSTEM SUPPLIER	DESIGN-BUILDER	72-I-002
73-FSW-V-0002	6"	175	O-C	FSW	WASTEWATER	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0003	6"	175	O-C	FBW	WASTEWATER	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0004	6"	175	O-C	FBW	WASTEWATER	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0005	6"	175	O-C	FBW	WASTEWATER	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0006	6"	175	O-C	FBW	WASTEWATER	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0007	8"	175	O-C	FSCM	WASTEWATER	IP	F		S	SE	WP	60 s	480v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0011	6"	175	O-C	FSW	WASTEWATER	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0014	6"	175	O-C	FBW	WASTEWATER	IP	F		S	SE	WP	60 s	120v	No	ELSCH				No	No	Yes	No	OUTFALL FILTRATION SUPPLIER	DESIGN-BUILDER	73-I-001

Schedule 40 05 62.16-S04
Eccentric Plug Valves Schedule
Pneumatic Actuators

Tag Number	Size	Rated Working Pressure	Type of Service(1)	Process Code	Application	Type of Installation(2)	Ends(3)	Maximum Differential Pressure Across Valve	High Pressure Side of Plug(5)	Remote Contorl Station(11)	Power For Solenoid Valve	Limit Switches(6)	Position Transmitter	Single Acting Spring Return	Extension Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Installed By	Furnished By*	P&I DWG No.
32-DRN-V-0001	6"			DRN	MIXED LIQUOR	IP	F	10	S			EOT	Yes	Yes	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-007
32-DRN-V-0002	6"	175		DRN	MIXED LIQUOR	IP	F	10	S			EOT	Yes	Yes	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-007

Notes:
(1) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(2) Abbreviations for installation types are as follows:

B4	Buried, depth of 4 feet [1.2 m] or less
B20	Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
B	Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet(Bxx)
SV20	Submerged or vaulted, depth 20 feet [6.1 m] or less
SV	Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of xx feet(SVXX)
IP	In plant

(3) Abbreviations for valve ends are as indicated:

F	Flanged
MJ	Mechanical joint
P	Push-on joint

(4) Abbreviations for manual actuator types are as indicated:

WN	Wrench Nut
LVR	Lever
CW	ChainWheel
HW	HandWheel

(5) Abbreviations for high pressure side of plug are as indicated:

S	Seating (plug shaft side)
U	Unseating (plug seat side)

(6) Abbreviations for limit switches on manual and cylinder operated valves.

EOT	End of travel (open - close)
PSS	Pump start - stop (two intermediate positions)
ELSCH	See electrical schematics

(7) Abbreviations for electronic or electric actuator housing.

WP	Weatherproof
SUB	Submersible [xx = depth of submergence](SUBxx)

EXP Explosion proof

(8) Abbreviations for control devices are as indicated.

Table 1: Control Devices				
Abbreviations	Open-Close Push Button	Open-Stop-Close Push Button	Local-Off-Remote	Red and Green Indicator Lights
A	Required		Required	Required
B	Required		Required	
C		Required	Required	Required
D		Required	Required	
E		Required		
F	Required			
G	Required			Required
H		Required		Required

(10) Abbreviations for electric actuator types are as follows:

SE Standard Electric
IE Intelligent Electric
NE Networked Electric

(11) Abbreviations for remote control station types:

CS Control Station without indicating lights.
CIS Control Station with indicating lights.

* Note: If Furnished by anyone other than Design-Builder, then some columns may be left blank. The valve furnisher shall provide their information.

END OF SCHEDULE

Section 40 05 63.53

MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of manually operated or remote activated two position (open-close) ball valves as specified herein.

Miscellaneous ball valves shall be provided where AWWA type ball valves are not required.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.

1-2.02. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2-1. CONSTRUCTION. Ball valves shown on the drawing, but not specified herein, shall be selected to match piping material they are installed in.

2-1.01. Valves Type VB-1.

VB-1 Instrument air, heating water, chilled water, and condenser water systems with copper pipe, ball valves indicated on the plumbing drawings for water service in metallic piping systems. 2 inch and smaller	Rating	500 psi nonshock cold WOG
	Code	MSS SP-110
	Type	In-line, two piece, end entry, full port
	Body/Bonnet	ASTM B584–C84400 bronze
	Trim	
	Seat	Reinforced Teflon
	Ball	Brass, or chrome plated brass
	Stem	Brass or bronze
	Thrust Washer	Reinforced Teflon
	Stem Seal	Teflon or Viton
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 77-100 Series"; Powell "Fig 4210T"

2-1.02. Valves Type VB-2.

VB-2 Ball valves indicated on the plumbing drawings for water service for metallic piping systems 2-1/2 inch and 3 inch	Rating	500 psi nonshock cold WOG
	Code	MSS SP-110
	Type	In-line, three piece, end entry, full port
	Body/Bonnet	ASTM B584-C84400 Bronze
	Trim	
	Seat	Reinforced Teflon
	Ball	Brass or chrome plated
	Stem	Brass or Bronze
	Thrust Washer	Reinforced Teflon
	Stem Seal	Teflon or Viton
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 82-100 Series"

2-1.03. Valves Type VB-3.

VB-3 Process air service 2 inch and smaller	Rating Code Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal End Connection Temp. Limitations Valve Operator Manufacturers	800 psi nonshock cold WOG MSS SP-110 In-line, two piece, end entry, regular port ASTM A351-CF8M, stainless steel Reinforced Teflon ASTM A276-316, stainless steel ASTM A276-316, stainless steel Reinforced Teflon Teflon or Viton Threaded End -20 to 400°F Lever Conbraco Industries "Apollo 76-100 Series"; Neles-Jamesbury "Series 4000"

2-1.04. Valves Type VB-4. Not used.

2-1.05. Valves Type VB-5.

VB-5 Compressed air, water service 2-1/2 inch	Rating Code Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Packing End Connection Temp. Limitations Valve Operator Manufacturers	Class 150 In-line, split-body, full port ASTM A216-WCB, cast steel Reinforced Teflon ASTM A216-WCB, steel, chrome plated ASTM A108-CS Reinforced Teflon Manufacturer’s standard Flanged, ASME B16.5, Class 150, raised face -20 to 400°F Lever Conbraco Industries "Apollo 88A-200 Series"

2-1.06. Valves Type VB-6.

VB-6 Compressed air, water service 3 inch and larger Flanged	Rating	Class 150
	Type	In-line, end entry, regular port
	Body/Bonnet	ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A216-WCB, steel, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Body Seal	Reinforced Teflon
	Stem Seal	Manufacturer's standard
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 88A-100 Series", Neles-Jamesbury "5000 Series", Powell "Fig 4224T"

2-1.07. Valves Type VB-7.

VB-7 Heating water, chilled water, and condenser water systems with steel pipe, compressed air service 2 inch and smaller	Rating	800 psi nonshock cold WOG
	Code	ASME B16.34
	Type	In-line, three piece, bolted body, full port
	Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A108-CS, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Socket weld
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever or Electric
	Manufacturers	Contromatics "C-1122-BB-DL", Conbraco Industries "Apollo 83-200 Series", Neles-Jamesbury "4DX2200TT"

	Valve Operator Lever	Contromatics “C-1122-BB-DLConbraco Industries “Apollo 83R-200 Series”, Neles-Jamesbury “4DX2200TT”
	Valve Operator Electric	Conbraco Industries “Apollo 83R-242”

2-1.08. Valves Type VB-8.

VB-8 Compressed air, water service 2-1/2 inch through 4 inch Butt weld	Rating	800 psi nonshock cold WOG
	Code	ASME B16.34
	Type	In-line, three piece, bolted body, regular port
	Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	Nickel or hard chrome plates carbon steel
	Stem	Nickel or hard chrome plated carbon steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Butt weld
	Temp. Limitations	-20 to 400°F [-29 to 204°C]
	Valve Operator	Lever
	Manufacturers	Worcester Controls “4546TTBW4”

2-1.09. Valves Type VB-9.

VB-9 Diesel fuel, lubrication oil 2 inch and smaller	Rating	Class 600
	Code	ASME B16.34
	Type	In-line, three piece, bolted body, firesafe, full port
	Body/Bonnet	ASTM A105, forged steel
	Trim	
	Seat	Reinforced Teflon primary, metal secondary
	Ball	Stainless steel
	Stem	Stainless steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon

	End Connection	Threaded End (socket weld end for aqua ammonia)
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever
	Manufacturers	Neles-Jamesbury "4B2236XT-1"

2-1.10. Valves Type VB-10.

VB-10 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section 4 inch and smaller Socket	Rating	150 psig nonshock cold WOG
	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon
	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system
	Thrust Washer	Teflon
	Stem Seal	Viton O-ring
	Body Seals	Viton O-rings
	End Connection	Socket
	Temp. Limitations	0 to 140°F
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co "True Union 2000 Standard Series 3600 Ball Valve"

2-1.11. Valves Type VB-11.

VB-11 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories	Rating	150 psig nonshock cold WOG
	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon

section 4 inch and smaller Flanged	Ball Stem Thrust Washer Stem Seal Body Seals End Connection Temp. Limitations Valve Operator Manufacturers	PVC or CPVC to match piping system PVC or CPVC to match piping system Teflon Viton O-ring Viton O-rings Flanged, ASME B16.5, Class 150, raised face 0 to 140°F Lever Hayward Plastic Products "True Union Ball Valve"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co. "True Union 2000 Standard Series 3600 Ball Valve"

2-1.12. Valves Type VB-12.

VB-12 Distilled water, deionized water service 1 inch and smaller	Rating Type Body/Bonnet Trim End Connection Valve Operator Manufacturers	150 psig at 73°F In-line, Tru-union, end entry, regular port Virgin unpigmented Type 1 Homopolymer Polypropylene Virgin unpigmented Type 1 Homopolymer Polypropylene Socket weld Lever Orion "Whiteline Riontite"

2-1.13. Valves Type VB-13. Not used.

2-1.14. Valves Type VB-14. Not used.

2-1.15. Valves Type VB-15. Not used.

2-1.16. Valves Type VB-16.

VB-16 Diesel fuel, lubrication oil 2 inch and smaller	Rating	Class 800
	Code	ASME B16.34
	Type	FM (Factory Mutual) approved emergency shutoff
	Body/Bonnet	Carbon Steel
	Trim	Stainless Steel
	Seat	Reinforced Teflon
	Ball	Stainless Steel
	Stem	Alloy 20
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	Fusible Link Temp. Rating	165ºF
	End Connection	Threaded End
	Temp. Limitations	-20 to 100°F
	Valve Operator	Spring Handle
	Release Mode	Spring-to-Close
	Manufacturers	Neles-Jamesbury "Figure 1075"

2-1.17. Valves Type VB-17.

VB-17 Water service 2 inch and smaller	Rating	2000 psi nonshock cold WOG
	Type	In-line, two piece, end entry, full port
	Body/Bonnet	ASTM B548-C84400, bronze
	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A276-316, stainless Steel
	Stem	ASTM A276-316, stainless Steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F
	Valve Operator	Electric Actuator
	Manufacturers	Conbraco Industries "Apollo 77-Arx-35-00 Series"

2-1.18. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

2-1.19. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces	
Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy.
Exterior Surfaces of all other valves	Universal primer.

2-2. VALVE ACTUATORS. Ball valve, except those which are equipped with power actuators or are designed for automatic operation, shall be provided with manual actuators. Unless otherwise specified or indicated on the drawings, each manual actuator shall be equipped with a lever operator. Ball valves with center lines more than 7'-6" above the floor shall be provided with chain levers.

Valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for

auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2-3. ACCESSORIES. If the drawings indicate the need for extension stems, stem guides; position indicator; floor boxes; valve boxes; or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

Section 40 05 64.22

INDUSTRIAL BUTTERFLY VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of manual or remote operated industrial butterfly valves as specified herein, as indicated on the P&IDs, and as indicated in the Industrial Butterfly Valve Schedule.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Powered actuators are covered in the Valve and Gate Actuators section.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Temporary Number Plates. Each industrial butterfly valve with an identifying number listed in the Industrial Butterfly Valve Schedule, shall be tagged or marked in the factory with the identifying number.

1-2.03. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

Drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

PART 2 - PRODUCTS

2-1. CONSTRUCTION. Unless otherwise specified, industrial butterfly valves shall be the rubber-seat, tight-closing type. Valves specified with an electric, air, or hydraulic actuators shall be the lugged wafer style. Valve discs shall seat at 90 degrees with the pipe axis.

Industrial butterfly valves with center lines more than 7'-6" above the floor shall be provided with chain-wheels and operating chains as specified herein.

Flanged end valves shall be of the short-body type. Where mechanical joint ends are specified, in the valve schedule, either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11 will be acceptable. For buried or submerged service, shaft seals shall be O-ring type.

2-1.01. Valves VBF-1.

VBF-1	Rating	150 psi shutoff
	Body	ASTM A126, Class B, cast iron
Heating water, chilled water, condenser water service	Trim	
	Seat	EPDM
	Disc	ASTM B148, Alloy 952, aluminum bronze, or Nylon 11 coated ductile iron
	Stem	ASTM A276, Grade 316 or 304, stainless steel
Wafer	Stem Seal	Synthetic O-rings
	Stem Packing	Buna-N
	Shaft Bearings	Upper and lower bearings or two upper bearings, bronze, reinforced Teflon, or acetal
	Shaft Seal	Synthetic rubber O-rings
	End Connection	Wafer
	Temperature Limitations	-20 to 250°F [-29 to 114°C]
	Manual Valve Operator	
	6" [150 mm] & smaller	Lever
	8" [200 mm] & larger	Geared Handwheel
	Manufacturer	Keystone "AR1", ABZ, Bray Series 30

2-1.02. Valves VBF-2.

VBF-2	Rating	150 psi shutoff
	Body	ASTM A126, Class B, cast iron
Process air, heating water, chilled water, condenser water service	Trim	
	Seat	EPDM
	Disc	ASTM B148, Alloy 952, aluminum bronze, or Nylon 11 coated ductile iron
	Stem	ASTM A276, Grade 304, 316, or 416, stainless steel
	Stem Seal	Synthetic O-rings
Lugged	Stem Packing	Buna-N

Wafer	Shaft Bearings	Upper and lower bearings or two upper bearings, bronze, reinforced teflon, or acetal
	Shaft Seal	Synthetic rubber O-rings
	End Connection	Wafer
	Temperature Limitations	-20 to 250°F [-29 to 114°C]
	Manual Valve Operator	
	6" [150 mm] & smaller	Lever
	8" [200 mm] & larger	Geared Handwheel
	Manufacturer	Keystone “AR2”, ABZ, Bray Series 31

2-1.03. Valves VBF-3. Not used.

2-1.04. Valves VBF-4.

VBF-4 Odor control scrubber solution recirculation and drain	Rating	Class 150
	Body	PVC, molded
	Shaft	AISI Type 316 stainless steel
	Trim	
	Seat	FPM (Viton) or EPDM
	Disc	PVC or polypropylene
	Stem	316 stainless steel
	Stem Seal	Synthetic O-rings
	Shaft Bearings	Upper and lower bearings, reinforced Teflon
	End Connection	Flanged, ASME B16.5, Class 150 diameter and drilling
	Temperature Limitations	TBD
	Manual Valve Operator	Lever
	Manufacturer	Asahi American “Type 56”, Chemtrol “Model B”

2-1.05. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch [1.6 mm] of the specified or theoretical length.

2-1.06. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	Specification Compliance
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Rust-Preventive Compound	As recommended by the manufacturer.
Universal Primer	As recommended by the manufacturer.

Surfaces to Be Coated	Material
Unfinished Surfaces	
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2-2. VALVE ACTUATORS. Manual actuated valves 6 inches and smaller, unless chain-wheel actuators are required, shall be provided with levers as specified herein. Valves 8 inches and larger shall have enclosed, geared, hand-wheel or chain-wheel actuators with position indicators as specified herein. Requirements for automatic valve actuators shall be as specified herein, as indicated in the Industrial Butterfly Valves Schedule, and as specified in the Valve and Gate Actuator section.

2-2.01. Manual Actuators. Manual actuators of the types listed herein and in the Industrial Butterfly Valves Schedule shall be provided by the valve manufacturer.

Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating hand-wheel.

The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

Actuators shall produce the required torque with a maximum pull of 80 lbs [356 N] on the lever, hand-wheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs [890 N] on the hand-wheel or chain-wheel or an input of 300 foot-lbs [407 J] on the operating nut.

2-2.02. Handwheels. Handwheel diameters shall be as recommended by the valve manufacturer.

2-2.03. Levers. Levers shall be capable of being locked in at least five intermediate positions between fully open and fully closed.

2-2.04. Chain-wheels. All valves with center lines more than 7'-6" above the floor shall be provided with chain-wheels and operating chains, unless otherwise specified in the Industrial Butterfly Valve Schedule. Each chain-wheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet [1.2 m] of the floor below the valve.

2-3. ACCESSORIES. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, torque tubes, and valves boxes shall be as specified in Valve and Gate Actuator section, and as indicated in the Industrial Butterfly Valves Schedule.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

Schedule 40 05 64.22-S01
Industrial Butterfly Valves Schedule
Manual Actuators

Tag Number	Size	Valve Type (8)	Process Code	Application	Type of Installation(1)	Minimum Actuator Torque Capability (in-lbs) (3)	Types of Manual acuator (7)	Limit Switches (4)	Extensions Stems	Position Indicator for Buried Valve Actuators	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Furnished By	Installed By	P & I DWG No.
23-ODC-V-0015	14"		FA		IP				No	No	No	No	No	No	PACKAGED ODOR CONTROL SYSYTEM SUPPLIER	DESIGN-BUILDER	23-I-001
23-ODC-V-1001	14"		FA		IP				No	No	No	No	No	No	PACKAGED ODOR CONTROL SYSYTEM SUPPLIER	DESIGN-BUILDER	23-I-001
31-AER-V-0107	8"	VBF-2	AA		IP		LVR	EOT	No	No	No	No	No	No	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-004
31-AER-V-0207	8"	VBF-2	AA		IP		LVR	EOT	No	No	No	No	No	No	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-004
31-AER-V-0307	8"	VBF-2	AA		IP		LVR	EOT	No	No	No	No	No	No	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-004
32-AIR-V-0107	6"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-006
32-AIR-V-0207	6"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-006
32-AIR-V-1101	3"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-AIR-V-1201	3"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-AIR-V-1301	3"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-AIR-V-2101	3"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-002
32-AIR-V-2201	3"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-002
32-AIR-V-2301	3"	VBF-2	AS		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-002
32-MEM-V-0007	12"	VBF-2	MFF		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-005
32-MEM-V-1006	10"	VBF-2	MFF		IP		HW	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-MEM-V-1012	8"	VBF-2	MFF		IP		HW	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-003
32-MEM-V-1102	6"	VBF-2	MFF		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-MEM-V-1202	6"	VBF-2	MFF		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-MEM-V-1302	6"	VBF-2	MFF		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-MEM-V-2006	10"	VBF-2	MFF		IP		HW	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-002
32-MEM-V-2012	8"	VBF-2	MFF		IP		HW	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-004
32-MEM-V-2102	6"	VBF-2	MFF		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-002
32-MEM-V-2202	6"	VBF-2	MFF		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-002
32-MEM-V-2302	6"	VBF-2	MFF		IP		LVR	EOT	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-002
33-RO-V-0101	12"	VBF-1	MFF		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	33-I-001
33-RO-V-0103	12"	VBF-1	MFF		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	33-I-001
33-RO-V-0201	12"	VBF-1	MFF		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	33-I-001
33-RO-V-0203	12"	VBF-1	MFF		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	33-I-001
34-PRW-V-0001	4"	VBF-1	PRW		IP		LVR	EOT	No	No	No	No	No	No	PRW PUMP STATION SUPPLIER	PRW PUMP STATION SUPPLIER	34-I-001
34-PRW-V-0101	3"	VBF-1	PRW		IP		LVR	EOT	No	No	No	No	No	No	PRW PUMP STATION SUPPLIER	PRW PUMP STATION SUPPLIER	34-I-001
34-PRW-V-0106	4"	VBF-1	PRW		IP		LVR	EOT	No	No	No	No	No	No	PRW PUMP STATION SUPPLIER	PRW PUMP STATION SUPPLIER	34-I-001
34-PRW-V-0201	3"	VBF-1	PRW		IP		LVR	EOT	No	No	No	No	No	No	PRW PUMP STATION SUPPLIER	PRW PUMP STATION SUPPLIER	34-I-001
34-PRW-V-0206	4"	VBF-1	PRW		IP		LVR	EOT	No	No	No	No	No	No	PRW PUMP STATION SUPPLIER	PRW PUMP STATION SUPPLIER	34-I-001
34-PRW-V-0301	3"	VBF-1	PRW		IP		LVR	EOT	No	No	No	No	No	No	PRW PUMP STATION SUPPLIER	PRW PUMP STATION SUPPLIER	34-I-001
34-PRW-V-0306	4"	VBF-1	PRW		IP		LVR	EOT	No	No	No	No	No	No	PRW PUMP STATION SUPPLIER	PRW PUMP STATION SUPPLIER	34-I-001
51-CIP-V-0014	6"	VBF-1	CIPS		IP		LVR	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-010
51-CIP-V-0015	2"	VBF-1	CIPS		IP		LVR	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-010
51-CIP-V-0016	6"	VBF-1	CIPS		IP		LVR	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-010
51-CIP-V-0101	6"	VBF-1	CIPR		IP		LVR	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-009
51-CIP-V-0104	4"	VBF-1	PCR		IP		LVR	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-009
51-CIP-V-0106	0"	TBD	OF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	DESIGN-BUILDER	51-I-009
51-CIP-V-0107	6"	TBD	CIPS		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	DESIGN-BUILDER	51-I-009
51-CIP-V-0108	0"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010
51-CIP-V-0111	0"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010
51-CIP-V-0201	6"	VBF-1	CIPR		IP		LVR	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-009
51-CIP-V-0204	0"	TBD	OF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	DESIGN-BUILDER	51-I-009
51-CIP-V-0205	3"	TBD	CIP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	DESIGN-BUILDER	51-I-009
51-CIP-V-0206	0"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010

Schedule 40 05 64.22-S01
Industrial Butterfly Valves Schedule
Manual Actuators

Tag Number	Size	Valve Type (8)	Process Code	Application	Type of Installation(1)	Minimum Actuator Torque Capability (in-lbs) (3)	Types of Manual acuator (7)	Limit Switches (4)	Extensions Stems	Position Indicator for Buried Valve Actuators	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Furnished By	Installed By	P & I DWG No.
51-CIP-V-0209	0"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010
51-RO-V-0017	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	DESIGN-BUILDER	51-I-011
51-RO-V-0018	2"	TBD	DRN		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	DESIGN-BUILDER	51-I-011
51-RO-V-0101	6"	TBD	ROF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0116	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-011
51-RO-V-0116	6"	TBD	ROF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0120	4"	TBD	FF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-011
51-RO-V-0201	6"	TBD	ROF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0216	6"	TBD	ROF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0216	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-011
51-RO-V-0220	4"	TBD	FF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-011
51-RO-V-0301	6"	TBD	ROF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0316	6"	TBD	ROF		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-1002	6"	TBD	CIPS		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1012	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1015	6"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1017	4"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1019	4"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1021	6"	TBD	CIPS		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1025	6"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1027	2 1/2"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1037	4"	TBD	PCR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-1039	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-1053	2 1/2"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-2002	6"	TBD	CIPS		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2012	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2015	6"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2017	4"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2019	4"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2021	6"	TBD	CIPS		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2025	6"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2027	2 1/2"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2037	4"	TBD	PCR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-2039	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-2053	2 1/2"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-3002	6"	TBD	CIPS		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3012	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3015	6"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3017	4"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3019	4"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3021	4"	TBD	CIPS		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3025	4"	TBD	CIPR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3027	2 1/2"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3037	4"	TBD	PCR		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
51-RO-V-3039	4"	TBD	ROP		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
51-RO-V-3053	2 1/2"	TBD	ROC		IP				No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
52-UV-V-0101	8"	VBF-1	ROP		IP		HW	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001
52-UV-V-0103	8"	VBF-1	UVE		IP		HW	ELSCH	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001

Schedule 40 05 64.22-S01
Industrial Butterfly Valves Schedule
Manual Actuators

Tag Number	Size	Valve Type (8)	Process Code	Application	Type of Installation(1)	Minimum Actuator Torque Capability (in-lbs) (3)	Types of Manual acuator (7)	Limit Switches (4)	Extensions Stems	Position Indicator for Buried Valve Actuators	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Furnished By	Installed By	P & I DWG No.
61-CAL-V-0005	10"	VBF-1	IPR		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0008	10"	VBF-1	IPR		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0101	1"	VBF-1	IPR		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0104	10"	VBF-1	UVE		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0105	8"	VBF-1	UVE		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0106	1"	VBF-1	IPR		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0201	8"	VBF-1	UVE		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0204	10"	VBF-1	UVE		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0205	10"	VBF-1	UVE		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
61-CAL-V-0206	8"	VBF-1	UVE		IP		HW	EOT	No	No	No	No	No	No	CALCITE SYSTEM SUPPLIER	DESIGN-BUILDER	61-I-001
62-TW-V-0001	8"	VBF-1	UVE		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	62-I-001
62-TW-V-0002	10"	VBF-1	IPR		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	62-I-001
62-TW-V-0005	10"	VBF-1	IPR		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	62-I-001
62-TW-V-0006	3"	VBF-1	DRN		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	62-I-001
63-TW-V-0101	6"	VBF-1	IPR		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
63-TW-V-0105	6"	VBF-1	IPR		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
63-TW-V-0201	6"	VBF-1	IPR		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
63-TW-V-0205	6"	VBF-1	IPR		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
63-TW-V-0301	6"	VBF-1	IPR		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
63-TW-V-0305	6"	VBF-1	IPR		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
64-TW-V-0002	20"	VBF-1	FOW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0004	20"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0005	3"	VBF-1	DRN		IP		LVR	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0101	14"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0104	14"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0201	14"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0204	14"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0301	10"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0304	10"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0401	10"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0404	10"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
65-POW-V-0002	24"	VBF-1	POW		IP		HW	EOT	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	65-I-001
71-AIR-V-0001	4"	VBF-1	AA		IP		LVR	N/A	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-003
71-AIR-V-0002	4"	VBF-1	AA		IP		LVR	N/A	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-003
71-AIR-V-0003	6"	VBF-1	AA		IP		LVR	N/A	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	71-I-003
72-NPW-V-0002	2"	VBF-1	PRW		IP		LVR	N/A	No	No	No	No	No	No	DEWATERING SYSTEM SUPPLIER	DESIGN-BUILDER	72-I-002

Schedule 40 05 64.22-S02
Industrial Butterfly Valves Schedule
Electric Actuators

Tag Number	Size	Valve Type (8)	Type of Service(6)	Process Code	Application	Type of Installation(1)	Minimum Actuator Torque Capability (in-lbs) (3)	Type of Electric Actuator(2)	Type of Housing(5)	Operating Time	Power for Actuator Motor	Actuator Provides 120 VAC For remote controls	Number of Limit Switch Assemblies	Position Transmitter	Control Devices(9)	Remote Control Station (10)	Extensions Stems	Position Indicator for Buried Valve Actuators	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Furnished By	Installed By	P & I DWG No.
31-AER-V-1101	6"	VBF-2	O-C	AA		IP	TBD	SE	WP	TBD		No	ELSCH	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-001
31-AER-V-1201	6"	VBF-2	O-C	AA		IP	TBD	SE	WP	TBD		No	ELSCH	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-001
31-AER-V-2101	6"	VBF-2	O-C	AA		IP	TBD	SE	WP	TBD		No	ELSCH	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-002
31-AER-V-2201	4"	VBF-2	O-C	AA		IP	TBD	SE	WP	TBD		No	ELSCH	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-002
32-RAS-V-1001	14"	VBF-2	M	RAS		IP	TBD	SE	WP	TBD		No	ELSCH	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	32-I-001
32-RAS-V-2001	14"	VBF-2	M	RAS		IP	TBD	SE	WP	TBD		No	ELSCH	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	32-I-002
51-CIP-V-0103	3"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-009
51-RO-V-0012	8"	TBD	O-C	ROF		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	51-I-001
51-RO-V-0013	2 1/2"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	DESIGN-BUILDER	51-I-011
51-RO-V-0107	4"	TBD	O-C	FF		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0207	4"	TBD	O-C	FF		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0307	4"	TBD	O-C	FF		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-1001	6"	TBD	O-C	ROF		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003
51-RO-V-1040	4"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-1042	4"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-1048	2 1/2"	TBD	O-C	ROC		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-2001	6"	TBD	O-C	ROF		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004
51-RO-V-2040	4"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-2042	4"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-2048	2 1/2"	TBD	O-C	ROC		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-3001	6"	TBD	O-C	ROF		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005
51-RO-V-3040	4"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
51-RO-V-3042	4"	TBD	O-C	ROP		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
51-RO-V-3048	2 1/2"	TBD	O-C	ROC		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
52-UV-V-0012	8"	TBD	O-C	UVE		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001
52-UV-V-0013	8"	TBD	O-C	UVE		IP	TBD	SE	WP	TBD		No	0	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001
61-CAL-V-0001	3"	VBF-2	O-C	D		IP		SE	WP	TBD		No	ELSCH	No	REFER TO P&ID	REFER TO P&ID	No	No	No	No	No	No	DESIGN-BUILDER	DESIGN-BUILDER	61-I-001

Schedule 40 05 64.22-S03
Industrial Butterfly Valves Schedule
Pneumatic Actuators

Tag Number	Size	Valve Type (8)	Type of Service(6)	Process Code	Application	Type of Installation(1)	Minimum Actuator Torque Capability(3)	Remote Control Station (10)	Power For Solenoid Valve	Limit Switches(4)	Position Transmitter	Single Acting Spring Return	Extensions Stems	Position Indicator for Buried Valve Actuators	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Furnished By	Installed By	P&I DWG No.
32-AIR-V-1001	6"	VBF-2	O-C	AS		IP		CS			No	No	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-001
32-AIR-V-2001	6"	VBF-2	O-C	AS		IP		CS			No	No	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-002
32-MEM-V-1005	10"	VBF-2	O-C	MFF		IP		CS			No	No	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-003
32-MEM-V-2005	10"	VBF-2	O-C	MFF		IP		CS			No	No	No	No	No	No	No	No	MBR SYSTEM SUPPLIER	MBR SYSTEM SUPPLIER	32-I-004

Notes:

(1) Abbreviations for installation types are as follows:

B4	Buried, depth of 4 feet [1.2 m] or less
B20	Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
B	Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet(Bxx)
SV20	Submerged or vaulted, depth 20 feet [6.1 m] or less
SV	Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of xx feet (SVxx)
IP	In plant

(2) Abbreviations for electric actuator types are as follows:

SE	Standard Electric
IE	Intelligent Electric
NE	Networked Electric

(3) This item applies only to powered actuators. The manufacturer's rated torque capacity for each butterfly valve actuator shall be at least equal to the actuator torque capacity specified herein. The minimum actuator torque capability indicated in the schedule may [1.3 L]. be reduced by 25 percent for pneumatic cylinder actuators larger than 80 cubic inches.

(4) Abbreviations for limit switches on manual and cylinder operated valves.

EOT	End of travel (open - close)
PSS	Pump start - stop (two intermediate positions)
ELSCH	See electrical schematics

(5) Abbreviations for electronic actuator or electric actuator housing.

WP	Weatherproof
SUB	Submersible [xx = depth of submergence] (Subxx)
EXP	Explosionproof

(6) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(7) Abbreviations for manual actuator types are as follows:

HW	Handwheel
CR	Crank
CW	Chainwheel
LVR	Lever
CLVR	Chain Lever
WN	Wrench Nut

(8) Valve Type – See Data Sheet.

(9) Abbreviations for control devices are as indicated.

Table 1: Control Devices

Abbreviations	Open-Close Push Button	Open-Stop-Close Push Button	Local-Off-Remote	Red and Green Indicator Lights

A	Required		Required	Required
B	Required		Required	
C		Required	Required	Required
D		Required	Required	
E		Required		
F	Required			
G	Required			Required
H		Required		Required

(10) Abbreviations for Remote Control Stations:

CS	Control Station without Indicating Lights
CIS	Control Station with Indicating Lights

End of Schedule

Section 40 05 67

GLOBE VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of manually operated or remote activated two position (open-close) globe valves as specified herein.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Coordination. All equipment provided under this section shall be furnished by or through a single manufacturer who shall be responsible for the design, coordination, and satisfactory performance of all components over the full operating range.

1-2.03. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1-2.04. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2-1. CONSTRUCTION.

2-1.01. Valves VGL-1.

VGL-1 Instrument air, clear water service 1/2 inch pipe and smaller	Rating Code Type Body/Bonnet Trim Seat Stem Bonnet Gasket Stem Packing End Connection Temp. Limitations Valve Operator Manufacturers	Class 200 MSS SP-80 In-line, union or threaded bonnet, rising stem, needle Bronze or brass Manufacturer’s standard Bronze Manufacturer’s standard Manufacturer’s standard Threaded 0 to 400°F [-18 to 204°C] Handwheel Milwaukee "600", Powell "Fig 180", Stockham "B-64".

2-1.02. Valves VGL-2.

VGL-2 Globe valves indicated on plumbing drawings, clear water service 3/4 to 2 inch pipe Threaded	Rating Code Type Body/Bonnet Trim Seat Disc Stem Bonnet Gasket Stem Packing End Connection Temp. Limitations Valve Operator Manufacturers	Class 125 MSS SP-80, Type 1 In-line, metal disc, threaded bonnet, rising stem ASTM B62, bronze Integral to body Bronze Bronze Manufacturer’s standard Manufacturer’s standard Threaded 0 to 350°F [-18 to 177°C] Handwheel Milwaukee "502", Stockham "B-16", Nibco “T-211”.

2-1.03. Valves VGL-3.

VGL-3	Rating	Class 125
	Code	MSS SP-80, Type 1
Clear water service	Type	In-line, metal disc, threaded bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
3/4 to 2 inch pipe	Seat	Integral to body
	Disc	Bronze
	Stem	Bronze
Soldered	Bonnet Gasket	Manufacturer’s standard
	Stem Packing	Manufacturer’s standard
	End Connection	Soldered
	Temp. Limitations	0 to 250°F [-18 to 121°C]
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1502", Stockham "B-17".

2-1.04. Valves VGL-4.

VGL-4	Rating	Class 150
	Code	MSS SP-80, Type 2
Instrument air compressed air service	Type	In-line, composition disc, union bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
3/4 to 2 inch pipe	Seat	Integral to body
	Disc	Teflon
	Stem	Bronze
Threaded	Bonnet Gasket	Manufacturer’s standard
	Stem Packing	Manufacturer’s standard
	End Connection	Threaded
	Temp. Limitations	0 to 350°F [-18 to 177°C]
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1590", Stockham "B-22T", Walworth "Fig 3095".

2-1.05. Valves VGL-5.

VGL-5	Rating	Class 150
	Code	
Instrument air, compressed air service	Type	In-line, composition disc, union bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
3/4 to 2 inch pipe	Seat	Integral to body
	Disc	Teflon
	Stem	ASTM B62, bronze
Soldered	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Teflon impregnated
	End Connection	Soldered
	Temp. Limitations	0 to 250°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1590".

2-1.06. Valves VGL-6.

VGL-6	Rating	Class 150
	Code	MSS SP-85, Type I
Globe valves indicated on plumbing drawings, instrument air, compressed air, clear water service	Type	In-line, bolted bonnet, OS&Y rising stem
	Body/Bonnet	ASTM A126 Class B, cast iron
	Trim	
	Seat Ring	ASTM B62, bronze
	Disc	ASTM B62, bronze
	Stem	Brass or silicone bronze
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
2-1/2 inch pipe and larger	End Connection	Flanged, ASME B16.1, Class 125, flat faced
	Temp. Limitations	0 to 250°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "F2981", Powell "Fig 1253", Walworth "8096F".

2-1.07. Valves VGL-7. Not used.

2-1.08. Valves VGL-8. Not used.

2-1.09. Valves VGL-9.

VGL-9 Chemical feed service 4 inch pipe and smaller	Rating	Class 150
	Type	In-line, threaded bonnet, rising stem
	Body/Bonnet	PVC
	Trim	
	Disc	Polypropolene
	Stem	PVC
	Stem Packing	EPDM or Viton
	End Connection	Socket welded (2 inch and smaller) Flanged, Class 150, (2-1/2 and larger)
	Temp. Limitations	0 to 140°F
	Valve Operator	Handwheel
	Manufacturers	Asahi “Model B”.

2-1.10. Valves VGL-10.

VGL-10 Chemical feed service 4 inch pipe and smaller	Rating	Class 150
	Type	In-line, threaded bonnet, rising stem
	Body/Bonnet	
	Trim	PVC
	Disc	Polypropolene
	Stem	Polypropolene
	Stem Packing	EPDM or Viton
	End Connection	Socket welded (2 inch and smaller) Flanged, Class 150, (2-1/2 and larger)
	Temp. Limitations	0 to 200°F
	Valve Operator	Handwheel
	Manufacturers	Asahi “Model B”.

2-1.11. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

2-1.12. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Asphalt Varnish	Fed Spec TT-C-494.
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2-2. VALVE ACTUATORS. Unless otherwise specified, globe valves shall be provided with handwheel type manual actuators. Handwheel diameter shall be manufacturers standard size.

Unless otherwise specified, valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 or Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2-3. ACCESSORIES. Requirements for extension stems and stem guides; position indicators; floor boxes; valve boxes; and operating stands shall be as specified in Valve and Gate Actuators section.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

Section 40 05 68

CHECK VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of check valves as specified herein and as indicated on the P&IDs, and as indicated in the Check Valve Schedule.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, unless exceptions are noted by Design-Builder.

Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Temporary Number Plates. Each check valve with an identifying number listed in the Check Valve Schedule, shall be tagged or marked in the factory with the identifying number.

1-2.03. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 – PRODUCTS

2-1. CONSTRUCTION.

The valve types are coverd in the Check Valve Schedule and coordinated with the P&IDs. Note not all valve types listed here exist in within the Proejct.

2-1.01. Valves VC-1.

VC-1 Air or vacuum service 1-1/2 inch [38 mm] or smaller pipe	Type Body Trim Poppet O-ring Spring End Connection Temp. Limitations Manufacturers	Poppet Stainless steel Stainless steel Viton (EPDM for aqua ammonia system air supply) Stainless steel Threaded -20 to 375°F [-29 to 191°C] Circle Seal “Series 200” or Swagelok “Series C”

2-1.02. Valves VC-2.

VC-2 Water, sludge, liquid service, or sump pump discharge Threaded ends 2 inch [25 mm] or smaller pipe	Rating Code Type Body/Bonnet Trim Seat Disc Hinge Pins End Connection Temp. Limitations Manufacturers	Class 125 AWWA C508 Horizontal swing, threaded bonnet ASTM B62 bronze Bronze, regrinding Bronze Manufacturer’s standard Threaded -20 to 212°F [-29 to 100°C] Stockham “B-321”, Walworth “Fig 3406”

2-1.03. Valves VC-3.

VC-3 Water, sludge, or liquid service	Rating Code Type Body/Bonnet Trim Seat	Class 125 AWWA C508 Horizontal swing, threaded bonnet ASTM B62 bronze Bronze, regrinding

Socket ends 2 inch [50 mm] or smaller pipe	Disc Hinge Pins End Connection Temp. Limitations Manufacturers	Bronze Manufacturer's standard Soldered -20°F to 212°F [-29°C to 100°C] Nibco "S-413-B", Walworth "Fig 3046SJ"

2-1.04. Valves VC-4.

VC-4 Air or vacuum service 2 inch [50 mm] or larger pipe	Rating Type Body Trim Seat Disc Hinge Hinge Pins Springs Bushings End Connection Temp. Limitations Manufacturers	Class 125 Dual disc wafer, full port Cast iron or carbon steel EPDM or Viton Aluminum Elastomeric Aluminum Stainless steel Manufacturer's standard Plain, installed between ASME B16.1, Class 125, flat faced flanges -20 to 300°F [-29 to 149°C] "Silent Seatless Check Valves" 09 Series as manufactured by US Valve of Rutherford, New Jersey or Flexi-Hinge Valve Company "Flexi-Hinge"

2-1.05. Valves VC-5.

VC-5 Digester gas or ozonated water services 2 inch [50 mm] and larger pipe	Rating Type Body Trim Seat Disc Hinge Pins/Stops Springs Bushings End Connection Temp. Limitations Manufacturers	Class 150 Dual disc wafer A351-CF8M, 316 Stainless steel TFE A351-CF8M, 316 Stainless steel A351-CF8M, 316 Stainless steel A351-CF8M, 316 Stainless steel TFE Plain, installed between ASME B16.5, Class 150 diameter and drilling -20 to 212°F [-29 to 100°C] Mueller Steam Specialty, "Model 72", Apco "Series 9000", Val-Matic

2-1.06. Valves VC-6.

VC-6 Water, sludge, or liquid service 2-1/2 inch [68 mm] and larger pipe	Rating	Class 125
	Code	AWWA C508
	Type	Horizontal swing, bolted bonnet
	Body/Bonnet	ASTM A126 Class B cast iron
	Trim	
	Seat Ring	Bronze
	Disc	Bronze
	Hinge Pins	Bronze or brass
	Bushings	Bronze
	Cover Gasket	Manufacturer's standard
	End Connection	Flanged, ASME B16.1 Class 125, flat faced
	Temp. Limitations	-20 to 212°F [-29 to 100°C]
	Manufacturers	Milwaukee "F-2974", Stockham "G-931"

2-1.07. Valves VC-7.

VC-7 Sump pump discharge service 3 inch [75 mm] and larger pipe	Rating	Class 125
	Code	AWWA C508
	Type	Horizontal swing, bolted bonnet
	Body/Bonnet	ASTM A126 Class B cast iron
	Trim	
	Seat Ring	ASTM B763 Alloy 84400 bronze
	Disc (3 inch)	ASTM B584 bronze
	(4 inch and larger)	ASTM A126 Class B cast iron
	Hinge Pins	Stainless steel
	Bearings	Bronze bushings
	Cover Gasket	Manufacturer's standard
	End Connection	Flanged, ASME B16.1 Class 125, flat faced
	Temp. Limitations	-20 to 212°F [-29 to 100°C]
	Valve Operator	Weighted lever
	Manufacturers	Mueller "A2604-6-01"

2-1.08. Valves VC-8.

VC-8 Low pressure clear water service 3 through 12 inch [75 through 300 mm] pipe	Rating	Class 125
	Type	Dual disc wafer
	Body	ASTM A126, Class B, cast iron
	Trim	
	Seat Ring	Buna-N
	Disc	ASTM B148 Alloy 952, aluminum bronze
	Springs/Hinge Pins/Stops	Stainless steel
	Bearings	Teflon
	End Connection	Plain, installed between ASME B16.1, Class 125, flat faced flanges
	Temp. Limitations	-20 to 225°F [-29 to 107°C] intermittent, 0 to 180°F [-18 to 82°C] continuous
	Manufacturers	Stockham “WG-970”, “Duo-Chek II 12HMP”, Apco Valve and Primer “9000AR1F”

2-1.09. Valves VC-9.

VC-9 High pressure clear water service 3 through 12 inch [75 through 300 mm] pipe	Rating	Class 250
	Type	Dual disc wafer
	Body/Bonnet	ASTM A126, Class B, cast iron
	Trim	
	Seat	Buna-N
	Disc	ASTM B148 Alloy 952, aluminum bronze
	Springs/Hinge Pins/Stops	AISI Type 316 stainless steel
	Bearings	Teflon
	End Connection	Plain, installed between ASME B16.1, Class 250, raised faced flanges
	Temp. Limitations	-20 to 225°F [-29 to 107°C] intermittent, 0 to 180°F [-18 to 82°C] continuous
	Manufacturers	Stockham “WG-970”, “Duo-Chek II Figure 30HMF”, Apco Valve and Primer “9200AR1R”

2-1.10. Valves VC-10.

VC -10 Wastewater pump discharge service 6 inch [150 mm] and larger pipe	Rating	Class 125
	Code	AWWA C508
	Type	Horizontal swing, bolted bonnet
	Body	ASTM A126 Class B cast iron
	Trim	
	Seat Ring	ASTM B763 Alloy 84400 bronze
	Disc	ASTM A126 Class B cast iron
	Hinge Pins	Stainless steel
	Bearings	Bronze bushings
	Cover Gasket	Manufacturer's standard
	End Connection	Flanged, ASME B16.1, Class 125, flat faced
	Temp. Limitations	-20 to 212°F [-29 to 100°C]
	Valve Operator	External spring or weighted lever
	Manufacturers	American Flow Control "52 SC", M&H "Style 259-02", Mueller "A2600-6-01 or 6-02"

2-1.11. Valves VC-11.

VC-11 Low pressure clear water service 14 inch [350 mm] and larger pipe	Rating	Class 125
	Type	Dual disc wafer
	Body	ASTM A126, Class B, cast iron or ductile iron
	Trim	
	Seat Ring	Buna-N
	Disc	ASTM B148 Alloy 952, aluminum bronze
	Springs/Hinge Pins/Stops	Stainless steel
	Bearings	Teflon
	End Connection	Plain, installed between ASME B16.1, Class 125, flat faced flanges
	Temp. Limitations	--20 to 225°F [-29 to 107°C] intermittent, 0 to 180°F [-18 to 82°C] continuous
	Manufacturers	Marlin "Wafer Check 125HZNSF", "Duo-Chek II Figure 12HMP", Apco Valve and Primer "9000AR1F"

2-1.12. Valves VC-12.

VC-12 High pressure clear water service 14 inch [350 mm] and larger pipe lines	Rating	250 psig
	Type	Dual disc wafer
	Body	ASTM A126, Class B, cast iron
	Trim	
	Seat Ring	Buna-N
	Disc	ASTM B148 Alloy 952, aluminum bronze or ductile iron with bronze trim
	Springs/Hinge Pins/Stops	AISI Type 316 stainless steel
	Bearings	Teflon
	End Connection	Plain, installed between ASME B16.1, Class 250, raised faced flanges
	Temp. Limitations	-20 to 225°F [-29 to 107°C] intermittent, 0 to 180°F [-18 to 82°C] continuous
	Manufacturers	Marlin “Wafer Check 250HZNSR”, “Duo-Chek II Figure 25HMF”, Apco Valve and Primer “9000AR1R”

2-1.13. Valves VC-13.

VC-13 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section Socket ends 3 inch and smaller PVC or CPVC pipe	Rating	150 psig [1 MPa] nonshock
	Type	Ball check, true union
	Body	PVC or CPVC, material shall match pipe material
	Trim	
	Ball	PVC or CPVC, material shall match pipe material
	Seat	Viton or EPDM
	Seals	Viton or EPDM
	End Connection	Socket
	Temp. Limitations	0 to 140°F [-18 to 60°C]
	Manufacturers	Hayward Plastics Products “Ball Check Valve”, Nibco “Chemtrol True Union Ball Check Valve”, Spears Manufacturing Co. “True Union 2000 Industrial Series 4500 Ball Check Valves”

2-1.14. Valves VC-14.

VC-14 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories Section Flanged ends 3 inch [75 mm] and smaller PVC or CPVC pipe	Rating Type Body/Bonnet Trim Ball Seat Seals End Connection Temp. Limitations Manufacturers	150 psig [1 MPa] nonshock Ball check, true union PVC or CPVC, material shall match pipe material PVC or CPVC, material shall match pipe material Viton or EPDM Viton or EPDM Flanged, ASME B16.5, Class 150, raised face 0 to 140°F [-18 to 60°C] Hayward Plastics Products “Ball Check Valve”, Nibco “Chemtrol True Union Ball Check Valve”, Spears Manufacturing Co. “True Union 2000 Industrial Series 4500 Ball Check Valves”

2-1.15. Valves VC-15.

VC-15 Chemical feed service 2 inch [50 mm] and smaller carbon steel pipe	Rating Type Body/Bonnet Trim Ball Seat Gasket Spring End Connection Temp. Limitations Manufacturers	Class 150 Spring loaded ball check with bolted removable cap Carbon steel Alloy steel A276 Stellite 6 316 Stainless Steel/Grafoil, Spiral Wound Stainless Steel Type 302 Socket welded 0 to 150°F [-18 to 66°C] Bonney Forge “HL51SW”

2-1.16. Valves VC-16.

VC-16 Chemical feed service 2 inch [50 mm] and smaller	Rating Type Body Trim Disc Seat Gasket	150 psig [1 MPa] nonshock Lift check (Disc) 316L Stainless Steel 316 Stainless Steel 316 Stainless Steel 316 Stainless Steel, Spiral

stainless steel pipe		Wound
	End Connection	Threaded
	Temp. Limitations	1,200 F at 600 psig
	Manufacturers	Conbraco “S90A”

2-1.17. Valves VC-17.

VC-17 Chemical piping vacuum relief service PVC or CPVC pipe	Rating	100 psig [690 kPa] nonshock
	Type	Diaphragm, two piece
	Body	PVC
	Trim	
	Diaphragm	Chemical resistant
	End Connection	Threaded
	Temp. Limitations	0 to 140°F [-18 to 60°C]
	Manufacturers	Plast-O-Matic “Series CKM Check Valves” or “Series VB Vacuum Breakers”

2-1.18. Valves VC-18.

VC-18 Chemical piping vacuum relief service 2 inch [50 mm] and smaller stainless steel pipe	Rating	3000 psig [20 MPa]
	Type	Vacuum Breaker, Universal Low Pressure
	Body	316 Stainless Steel
	Trim	
	Seat	Chemically resistant
	End Connection	Threaded
	Temp. Limitations	700°F [371°C]
	Manufacturers	Check-All Valves “UN-3-100-SS-E” or equal

2-1.19. Valves VC-19.

VC-19 Chemical piping vacuum relief service Carpenter 20 pipe	Rating	3000 psig [20 MPa] nonshock
	Type	Vacuum breaker, Universal low pressure check valve
	Body/Bonnet	Carpenter 20 Cb-3
	Trim	
	Seat	Teflon
	End Connection	Threaded
	Temp. Limitations	0 to 140°F [-18 to 60°C]
	Manufacturers	Check-All Valves “UN-3-XXX-A-20-T” or equal

2-1.20. Valves VC-20.

VC-20 Process Air Service for use with rotary positive displacement blowers	Max Pressure drop across valve Type End Connection Temp. Limitations Manufacturers	3 inch W.C. Full port, silent seatless type Flanged 0 to 300°F 09 Series US Valve

2-1.21. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard°891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.

Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

Schedule 40 05 68-S01
Check Valves Schedule

Tag Number	Size	Valve Type	Service	Process Code	Design Capacity	Ends(1)	Furnished By	Installed By	P and I DWG No.
31-AER-V-0106	8"	VC-20	AIR	AA		F	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-004
31-AER-V-0206	8"	VC-20	AIR	AA		F	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-004
31-AER-V-0306	8"	VC-20	AIR	AA		F	PROCESS AIR BLOWER SYSTEM SUPPLIER	DESIGN-BUILDER	31-I-004
31-NAOH-V-0002	1/2"	VC-15	SODIUM HYDROXIDE	NAOH	2.5	SOCKET WELDED	DESIGN-BUILDER	DESIGN-BUILDER	31-I-001
31-SCM-V-0005	3"	VC-6	WASTE ACTIVATED SLUDGE	WAS	60	F	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
31-WAS-V-0009	3"	VC-6	WASTE ACTIVATED SLUDGE	WAS	60	F	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003
32-AIR-V-0106	6"	VC-20	AIR	AS		F	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-006
32-AIR-V-0206	6"	VC-20	AIR	AS		F	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-006
32-CA-V-1002	1"	VC-13	CA	CA	2.5	F	DESIGN-BUILDER	DESIGN-BUILDER	32-I-001
32-CA-V-2002	1"	VC-13	CA	CA	2.5	F	DESIGN-BUILDER	DESIGN-BUILDER	32-I-002
32-DRN-V-0006	6"	VC-6	MIXED LIQUOR	DRN		SEE SPECIFICATION	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-007
32-MEM-V-1015	1/2"	VC-2	MFF	MFF		SEE SPECIFICATION	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-003
32-MEM-V-2015	1/2"	VC-2	MFF	MFF		SEE SPECIFICATION	MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-004
32-NOCL-V-1002	1"	VC-13	NOCL	NACL	2.5	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	32-I-001
32-NOCL-V-2002	1"	VC-13	NOCL	NACL	2.5	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	32-I-002
33-LAS-V-0002	1"	VC-13	LAS	LAS		SEE SPECIFICATION	DESIGN-BUILDER	DESIGN-BUILDER	33-I-001
33-NACL-V-0012	1"	VC-13	NOCL	NACL		SEE SPECIFICATION	DESIGN-BUILDER	DESIGN-BUILDER	33-I-001
34-NACL-V-0002	1"	VC-13	NOCL	NACL	0	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	34-I-001
34-PRW-V-0105	4"	VC-8	RECYCLED WATER	PRW		SEE SPECIFICATION	PRW PS SUPPLIER	DESIGN-BUILDER	34-I-001
34-PRW-V-0205	4"	VC-8	RECYCLED WATER	PRW		SEE SPECIFICATION	PRW PS SUPPLIER	DESIGN-BUILDER	34-I-001
34-PRW-V-0305	4"	VC-8	RECYCLED WATER	PRW		SEE SPECIFICATION	PRW PS SUPPLIER	DESIGN-BUILDER	34-I-001
51-ANTI-V-0002	1"	VC-13	ANTISCALE	ANTI	0	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	51-I-001
51-CIP-V-0110		VC-13	RO SKID	CIPR			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010
51-CIP-V-0208		VC-13	RO SKID	CIPR			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010
51-HSO4-V-0002	1"	VC-13	DILUTE SULFURIC	SA	0.01	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	51-I-001
51-NACL-V-0005	1/2"	VC-13	HYPOCHLORITE	NACL		SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	51-I-006
51-RO-V-0106	6"	VC-21	RO SKID	ROF			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0119	4"	VC-13	RO SKID	FF			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-011
51-RO-V-0206	6"	VC-21	RO SKID	ROF			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-0219	4"	VC-13	RO SKID	FF			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-011
51-RO-V-0292	6"	VC-13	CIP SOLUTION	CIPR	300	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	51-I-010
51-RO-V-0306	6"	VC-21	RO SKID	ROF			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002
51-RO-V-1038	4"	VC-13	RO SKID	PCR			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-1041	4"	VC-13	RO SKID	ROP			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-1052	2 1/2"	VC-13	RO SKID	ROC			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006
51-RO-V-2038	4"	VC-13	RO SKID	PCR			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-2041	4"	VC-13	RO SKID	ROP			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-2052	2 1/2"	VC-13	RO SKID	ROC			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007
51-RO-V-3038	4"	VC-13	RO SKID	PCR			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
51-RO-V-3041	4"	VC-13	RO SKID	ROP			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
51-RO-V-3052	2 1/2"	VC-13	RO SKID	ROC			REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008
52-HSO4-V-0002	1"	VC-13	DILUTE SULFURIC	SA	0	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001
52-NOCL-V-0002	1"	VC-13	HYPOCHLORITE	NACL	0.02	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001
52-UV-V-0001	8"	VC-13	ROP	ROP	215	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001
61-CAL-V-0007	10"		PRODUCT WATER	IPR			CALCITE SYSTEM SUPPLIER	CALCITE SYSTEM SUPPLIER	61-I-001
62-NAOH-V-0002	1/2"	VC-13	SODIUM HYDROXIDE	NAOH	0	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	62-I-001

Schedule 40 05 68-S01
Check Valves Schedule

Tag Number	Size	Valve Type	Service	Process Code	Design Capacity	Ends(1)	Furnished By	Installed By	P and I DWG No.
62-NOCL-V-0002	1"	VC-13	SODIUM HYPOCHLORITE	NACL	1.08	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	62-I-001
63-TW-V-0104	6"	VC-6	PRODUCT WATER	IPR	323	F	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
63-TW-V-0204	6"	VC-6	PRODUCT WATER	IPR	323	F	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
63-TW-V-0304	6"	VC-6	PRODUCT WATER	IPR	323	F	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001
64-TW-V-0103	14"	VC-6	PRODUCT WATER	POW	2840	F	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0203	14"	VC-6	PRODUCT WATER	POW	2840	F	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0303	10"	VC-6	PRODUCT WATER	POW	950	F	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
64-TW-V-0403	10"	VC-6	PRODUCT WATER	POW	950	F	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001
65-NHS-V-0002	1"	VC-13	SODIUM BISULFITE	NHS	0.19	SOCKET	DESIGN-BUILDER	DESIGN-BUILDER	65-I-001
65-POW-V-0001	24"	VC-6	PRODUCT WATER	POW	5653	F	DESIGN-BUILDER	DESIGN-BUILDER	65-I-001
71-AIR-V-0106	4"	VC-20	AIR	AA			BLOWER SUPPLIER	DESIGN-BUILDER	71-I-003
71-AIR-V-0206	4"	VC-20	AIR	AA			BLOWER SUPPLIER	DESIGN-BUILDER	71-I-003
72-DWT-V-0107	6"		AERATED WAS	AWS			DEWATERING SYSTEM SUPPLIER	DESIGN-BUILDER	72-I-001
72-DWT-V-0207	6"		AERATED WAS	AWS			DEWATERING SYSTEM SUPPLIER	DESIGN-BUILDER	72-I-001
72-POLF-V-0001	3"		POLYMER	POLF			DEWATERING SYSTEM SUPPLIER	DESIGN-BUILDER	72-I-002
73-FSW-V-0010	6"		WASTEWATER	FSW			CLOTH DISC/SAFE FILTER SUPPLIER	DESIGN-BUILDER	73-I-001
73-FSW-V-0012	6"		WASTEWATER	FBW			CLOTH DISC/SAFE FILTER SUPPLIER	DESIGN-BUILDER	73-I-001
81-FUE-V-0003	0"			GEN		T			81-I-001
90-HSO4-V-0101	1 1/2"			SA			DESIGN-BUILDER		90-I-007
90-HSO4-V-0101	1 1/2"			SA			DESIGN-BUILDER		90-I-007
90-HSO4-V-0101	1 1/2"			SA			DESIGN-BUILDER		90-I-007
90-HSO4-V-0201	1 1/2"			SA			DESIGN-BUILDER		90-I-007
90-NAOH-V-0005	3"			NAOH			DESIGN-BUILDER		90-I-003
90-NOCL-V-0005	3"			NACL			DESIGN-BUILDER		90-I-001
95-SAN-V-0001	4"			SAN			SANITARY LIFT STATION SYSTEM SUPPLIER		95-I-001
95-SAN-V-0002	4"			SAN			SANITARY LIFT STATION SYSTEM SUPPLIER		95-I-001
95-SAN-V-0007	6"			SAN			DESIGN-BUILDER		95-I-001
95-SAN-V-0008	6"			SAN			DESIGN-BUILDER		95-I-001
95-STW-V-0005	2"			STW			SANITARY LIFT STATION SYSTEM SUPPLIER		95-I-001

Notes:

(1) Abbreviations for valve ends are as indicated:

F
MJ
P

END OF SCHEDULE

Section 40 05 73.13

PRESSURE REDUCING VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of pressure reducing valves as specified herein.

Piping, pipe supports, insulation, and accessories which are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Valves specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.

Type and model.

Construction materials and finishes.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

1-3.02. Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Pressure reducing valves shall be designed to meet the service requirements as indicated herein[].

Each pressure reducing valve shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.

2-2. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Construction paragraph.

2-3. MATERIALS. Valve materials shall be as indicated below and in the Construction paragraph.

Shop Coatings

Epoxy Enamel, NSF certified (Liquid Service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus"; immersion service.
Epoxy Enamel (Gas and Air Service)	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".

2-4. CONSTRUCTION.

2-4.01. Water Service. Not Used.

2-4.02. Gas Service. Pressure reducing valves for natural gas and propane gas service shall be suitable for gases with specific gravities of 0.6 and 1.5, respectively. Natural gas and propane gas pressure reducing valves shall be direct-acting type with cast iron or cast steel bodies, threaded ends, aluminum trim, and a nitrile diaphragm and disc. Valves shall be Fisher Controls "HSR or S-202 Series".

2-4.03. Air Service. Pressure reducing valves for air service shall have a cast iron or steel body with stainless steel trim and a composition disc. Pressure reducing valves shall be furnished with integral or line mounted inlet filters/strainers and discharge pressure gauges. Valves shall be provided with flanged or socket weld connections. Socket weld locations shall be at sufficient to prevent damage to elastomeric valve components. Valves shall be as manufactured by Fisher Controls; O. C. Keckley Co.; Leslie Controls, Inc.; Spirax Sarco, Inc; or equal.

2-5. SHOP PAINTING. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop painted for corrosion protection in accordance with the following list. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Protective Coatings section.

Interior Surfaces	
Gas and Air Service	Epoxy.
Exterior Surfaces	Universal primer with epoxy finish coat.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

Section 40 05 84.11

PINCH AND DIAPHRAGM VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of manually operated or remote activated two position (open-close) or modulating pinch and diaphragm valves.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in the Valve and Gate Actuator section.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. PINCH VALVE CONSTRUCTION.

2-1.01. Valves VPN-1.Pinch valves shall consist of the valve body, elastomer sleeve liner, pinch bars, pull bars, actuator shaft, actuator base plate or yoke, actuator and assembly hardware. The valves shall be opened and closed with two mechanical pinch bars that constrict the elastomer sleeve liner between the bars. The pinch bars shall be enclosed inside the valve body. The top pinch bar shall be raised and lowered by a center actuator shaft. The lower pinch bar shall be raised and lowered with two pull bars anchored to the actuator base plate or yoke.

Valves shall provide 100 percent of the port area of the joining pipe at the valve ends and, unless otherwise specified, through the entire length of the valve. Valves shall be capable of closing bubble tight against the maximum line pressure.

2-1.02. Valve Body. Pinch valves shall be enclosed, split body design. All valves shall have flanged ends compatible with connecting piping. Flange diameter and drilling shall conform to ANSI B16.1, Class 125. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter.

2-1.03. Elastomer Sleeve Liner. Pinch valves shall be equipped with a one piece, seamless flange-to-flange elastomer sleeve liner specifically designed for the specified service conditions. The elastomer sleeve shall be compression molded or hand wrapped and reinforced with polyester cord ply. Pull tabs attached to the cord ply and extending through the exterior elastomer coating shall be furnished for attachment to the pinch bars to ensure positive opening force under negative pipeline pressure.

VPN-1	Rating	Class 125
	Body	Cast iron, ASTM A48
	Trim	
	Elastomer Sleeve Liner	Buna-N with polyester reinforcing cord ply
	Pull and Pinch Bars	Ductile iron or carbon steel when enclosed. Stainless steel, AISI Type 316 when exposed.
	Stem and Guide Rods	Stainless steel, AISI Type 316
	Assembly Hardware	Stainless steel, AISI Type 316
	End Connection	Flanged, ASME B16.1, Class 125, flat faced
	Valve Operator	Manual with handwheel
	Temp. Limitations	40 to 225°F [4 to 107°C]
	Pressure Limitations	
	6 inch and smaller	150 psig [1.0 MPa]
	8 and 12 inch	100 psig [690 kPa]
	14 inch and larger	50 psig [345 kPa]
	Manufacturers	Onyx Valve Co. “Model DHC”, RF Technologies, Inc. “RF Valve”, or Red Valve, “Series 75”, RKL Moyno Inc., or Flexible Valve Co.

2-1.04. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch [1.6 mm] of the specified or theoretical length.

2-1.05. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Asphalt Varnish	Fed Spec TT-C-494.
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard°891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2-2. DIAPHRAGM VALVE CONSTRUCTION.

2-2.01. Valves VD-1. Diaphragm valves used in sodium hypochlorite service shall be provided with socket weld ends. Flanged ends may be used where required to facilitate disassembly of piping or equipment, or where acceptable to the Design-Builder.

VD-1	Rating	Class 150
	Body	CPVC
	Trim	
	Diaphragm	Two-piece unbonded, Teflon and EPDM
	End Connection	Socket weld, flanged, ASME B16.1, Class 125, flat faced
	Operator	Handwheel with travel-stop & position indicator
	Manufacturers	Asahi/America “Type G”, “Type 14 Diaphragm Valves”, or “Type 15 Diaphragm Valves”, ITT “Dia-Flo Valves”

2-3. VALVE ACTUATORS. Manual actuated valves shall be provided with handwheels as specified herein. Requirements for automatic valve actuators shall be as specified herein, as indicated in the Valve Schedule, and as specified in the Valve and Gate Actuators section.

2-3.01. Manual Actuators. Manual actuators of the types listed herein and in the Pinch and Diaphragm Valve Schedule, shall be provided by the valve manufacturer.

Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

The direction of rotation of the wheel to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

Actuators shall produce the required torque with a maximum pull of 80 lbs [356 N] on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs [890 N] on the handwheel or chainwheel or an input of 300 foot-lbs [407 J] on the operating nut.

2-3.02. Handwheels. Handwheel diameters shall be as recommended by the valve manufacturer.

2-3.03. Chainwheels. Not used.

2-4. ACCESSORIES. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, torque tubes, and valve boxes shall be as specified in the Valve and Gate Actuators section and as indicated in the Valves Schedule.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

Section 40 05 86

AIR VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing air-release valves, combination air valves, air/vacuum valves and vacuum relief valves as required by the Work.

1-2. GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer.
Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Governing Standard. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable performance requirements of ANSI/AWWA C512.

1-2.03. Identification. Air valves shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete assembly drawings, together with detailed specifications and data covering materials used and accessories forming a part of the valves furnished, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. CONSTRUCTION. Air release valves for clean water applications with operating pressures of 150 psi or less shall be Apco/Valve and Primer "No. 200", GA Industries "Figure 920m", Multiplex "Crispin Type PL", ARI “No. S-050”, or Val-Matic "No. 38". Air release valves for working pressures below 20 psi shall be provided with soft seats.

Air release valves for wastewater applications with operating pressures of 300 psi or less shall be Apco/Valve and Primer “No. 400 or 450”, Multiplex “Crispin S Series”, ARI “No. S-020”, or Val-Matic “VM-48A or 49A”.

Vacuum relief valves shall be globe body type designed for full vacuum relief protection. The valve shall be provided with a steel head to prevent entrance of debris, shall have brass plug and resilient seat, and shall normally be kept closed by a stainless steel spring. Valves shall be Apco/Valve and Primer “Series 1500”, GA Industries “Figure 990 High Capacity Vacuum Relief & Air Inlet Valve, or Val-Matic “High Flow Vacuum Relief Valve”. Vacuum relief valves shall be provided with a side mounted air release valve.

Three inch and smaller air release and vacuum relief valves for clean water applications shall be integral type, Apco/Valve Primer “Series 140”, Multiplex “Crispin AL Series”, or Val-Matic “Air/Vacuum Valves”.

Four inch and larger air release and vacuum relief valves for clean water applications shall be integral type, Apco/Valve Primer “Series 1900”, Multiplex “Crispin AL Series”, or Val-Matic “Air/Vacuum Valves”. Unless otherwise specified or indicated on the Drawings, valves shall be provided with surge check discs on the valve inlet to restrict the exhaust air flow rate.

Two inch and smaller combination air valves for clean water applications shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer "Single Body Combination Air Valves", Multiplex "Crispin Universal Air Release Valves", ARI “No. D-040”, or Val-Matic "Combination Air Valves".

Three inch and larger combination air valves for clean water applications shall consist of an air and vacuum valve with an externally mounted air release valve. The valves shall be Apco/Valve and Primer “Single Body Combination Air Valves” for 3 inch and "Custom Combination Air Valves" for 4 inch and larger, GA Industries "Figure 950 Kinetic Custom Combination Air Valves", Multiplex "Crispin Dual Air Valves", ARI “No. D-060-HF”, or Val-Matic "Dual Body Combination Air Valves". Unless otherwise specified or indicated on the Drawings, valves shall be provided with surge check discs on the valve inlet to restrict the exhaust air flow rate.

Combination air valves for wastewater applications shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer “No. 440”, GA Industries “Figure 942”, Multiplex “Crispin US Series”, ARI “No. D-020”, or Val-Matic “VM-801A or VM-804”

2-2. MATERIALS. Except as modified or supplemented herein, materials of construction shall comply with the governing standard.

Valve Trim	Bronze or austenitic stainless steel or polymer materials. Valve trim for valves in wastewater service shall be austenitic stainless steel.
Float	Austenitic stainless steel, polycarbonate, or foamed polypropylene.
Shop Coatings	
Epoxy (NSF-61 Certified)	PPG Amercoat “Amerlock 400 High Solids Epoxy”, Carboline “Carboguard 891”, Sherwin-Williams "Macropoxy 646NSF" or Tnemec “Series N140 Pota-Pox Plus”.
Epoxy	PPG Amercoat “Amercoat 385 Epoxy”, Carboline “Carboguard 890”, Sherwin-Williams "Macropoxy 646" or Tnemec “Series N69 Hi-Build Epoxoline II”.
Rust-Preventive Compound	As recommended by manufacturer.

2-3. SHOP PAINTING. All interior and exterior ferrous metal surfaces, except stainless steel components, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating.

Surfaces shall be painted as indicated:

Interior Surfaces of Valves in Clean Water Applications (Raw or Treated Water in Potable Water Facilities)	NSF-61 Certified Epoxy.
Interior Surfaces of Valves in Wastewater Applications	Epoxy
Exterior Surfaces of Valves To Be Installed in Manholes or Valve Vaults	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

Interior epoxy coatings for clean water valves shall comply with ANSI/AWWA C550/NSF 61. Interior coatings for all valves shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils
Universal Primer	3 mils

2-4. SHUTOFF VALVES. A shutoff valve shall be provided in the piping leading to each air valve. Shutoff valves 2 inches and smaller shall be ball valves as specified in the Miscellaneous Ball Valves section. Shutoff valves 3 inches and larger for wastewater service shall be eccentric plug valves as specified in the Eccentric Plug Valve section.

Each 4 inch and larger combination air valve shall be provided with a shutoff valve between the air and vacuum valve and the air release valve.

PART 3 - EXECUTION

3-1. INSTALLATION. Air release and combination air valves shall be installed in accordance with the Valve Installation section.

End of Section

Schedule 40 05 86-S01
Air Valves Schedule

Tag Number	Valve Type(1)	Location(2)	Inlet size	Outlet Size	Orifice Size	Inlet Type(3)	Outlet Type(4)	Working Pressure (psi)	Furnished By	Installed By	P&ID Dwg No.	Comments
31-SCM-V-0003	ARV	IP						35	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003	
31-WAS-V-0007	ARV	IP						35	DESIGN-BUILDER	DESIGN-BUILDER	31-I-003	
32-MEM-V-0001	ARV	IP	By MBR System Supplier						MBR SYSTEM SUPPLIER	DESIGN-BUILDER	32-I-005	SIZE TO BE PROVIDED BY MSS
34-PRW-V-0108	CAV	IP						80	PRW PS SUPPLIER	PRW PS SUPPLIER	34-I-001	
34-PRW-V-0208	CAV	IP						80	PRW PS SUPPLIER	PRW PS SUPPLIER	34-I-001	
34-PRW-V-0308	CAV	IP						80	PRW PS SUPPLIER	PRW PS SUPPLIER	34-I-001	
51-CIP-V-0002	CAV	IP				TBD	TBD	TBD	DESIGN-BUILDER	DESIGN-BUILDER	51-I-009	
51-CIP-V-0007	CAV	IP	BY ROSS						REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010	SIZE TO BE PROVIDED BY ROSS
51-CIP-V-0009	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010	SIZE TO BE PROVIDED BY ROSS
51-CIP-V-0018	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-010	
51-RO-V-0011	CAV	IP				TBD	TBD	See pipeline schedule	DESIGN-BUILDER	DESIGN-BUILDER	51-I-001	
51-RO-V-0109	ARV	IP	BY ROSS						REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002	SIZE TO BE PROVIDED BY ROSS
51-RO-V-0111	ARV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002	SIZE TO BE PROVIDED BY ROSS
51-RO-V-0209	ARV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002	SIZE TO BE PROVIDED BY ROSS
51-RO-V-0211	ARV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002	SIZE TO BE PROVIDED BY ROSS
51-RO-V-0309	ARV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002	SIZE TO BE PROVIDED BY ROSS
51-RO-V-0311	ARV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-002	SIZE TO BE PROVIDED BY ROSS
51-RO-V-1012	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-003	SIZE TO BE PROVIDED BY ROSS
51-RO-V-1033	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006	SIZE TO BE PROVIDED BY ROSS
51-RO-V-1046	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-006	SIZE TO BE PROVIDED BY ROSS
51-RO-V-2012	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-004	SIZE TO BE PROVIDED BY ROSS
51-RO-V-2033	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007	SIZE TO BE PROVIDED BY ROSS
51-RO-V-2046	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-007	SIZE TO BE PROVIDED BY ROSS
51-RO-V-3012	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-005	SIZE TO BE PROVIDED BY ROSS
51-RO-V-3033	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008	SIZE TO BE PROVIDED BY ROSS
51-RO-V-3046	CAV	IP							REVERSE OSMOSIS SYSTEM SUPPLIER	REVERSE OSMOSIS SYSTEM SUPPLIER	51-I-008	SIZE TO BE PROVIDED BY ROSS
52-ROP-V-0004	CAV	IP						15	DESIGN-BUILDER	DESIGN-BUILDER	52-I-001	
63-TW-V-0107	CAV	IP	2"	2" Vent-o-mat rgx-II, Vent Tech WTR, or equa				20	DESIGN-BUILDER	DESIGN-BUILDER	63-I-001	
64-TW-V-0106	CAV	IP						30	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001	
64-TW-V-0107	CAV	IP						30	DESIGN-BUILDER	DESIGN-BUILDER	64-I-001	
65-POW-V-0003	CAV	IP	3"	3" Vent Tech SWG CARV				30	DESIGN-BUILDER	DESIGN-BUILDER	65-I-001	
65-POW-V-0004	ARV	IP						30	DESIGN-BUILDER	DESIGN-BUILDER	65-I-001	
65-POW-V-0007	CAV	IP						30	DESIGN-BUILDER	DESIGN-BUILDER	65-I-001	
65-POW-V-0008	CAV	IP						30	DESIGN-BUILDER	DESIGN-BUILDER	65-I-001	
72-DWT-V-0105	ARV	IP						43	DEWATERING SYSTEM SUPPLIER	DESIGN-BUILDER	72-I-001	
72-DWT-V-0205	ARV	IP						43	DEWATERING SYSTEM SUPPLIER	DESIGN-BUILDER	72-I-001	
73-FOW-V-001	ARVR	IP						2	DESIGN-BUILDER	DESIGN-BUILDER	73-I-001	

Notes:

(1) Abbreviations for types are as indicated:

ARV	Air Release Valve
CAV	Combination Air Valve
ARVR	Air Release and Vacuum Relief Valve
VRV	Vacuum Relief Valve

(2) Abbreviations for locations are as indicated:

IP	In-plant
IV	In-vault

(3) Abbreviations for inlet types are as indicated:

T	Threaded, ANSI/ASME B1.20.1, NPT
125F	Flanged, ANSI/ASME B16.1, Class 125
250F	Flanged, ANSI/ASME B16.1, Class 250

(4) Abbreviations for outlet types are as indicated:

T	Threaded, ANSI/ASME B1.20.1, NPT
125F	Flanged, ANSI/ASME B16.1, Class 125
PH	Protective hood

End of Schedule

Section 40 05 88.11

SOLENOID VALVES

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of manually operated or remote activated two position (open-close) solenoid operated valves.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Identification. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. CONSTRUCTION. Solenoid valves shall have packless construction without packing box or sliding seal.

Solenoid coils for DC service shall be 125 volts, Class H, for continuous duty at rated voltage ± 10 percent and 40°C ambient, in a NEMA Type 4 enclosure, with a conduit knockout.

Valves shall be normally closed unless otherwise specified or indicated on the drawings. Normally open solenoid valves shall close when energized and normally closed solenoid valves shall open when energized.

2-1.01. Valves Type VSOL-1.

VSOL-1	Type	2-Way, pilot operated
	Body/Bonnet	Brass or bronze
	Trim	
	Seals	Buna-N or Teflon
	Disc	Buna-N or Teflon
	Stem	Manufacturer's standard
	Bonnet Gasket	Manufacturer's standard
	Spring	Manufacturer's standard
	End Connection	Threaded
	Temp. Limitations	32 to 104°F [0 to 40°C]
	Valve Operator	Integral
	Manufacturers	ASCO "8210 Series"

2-1.02. Valves Type VSOL-2. Not used.

2-1.03. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within ± 1/16 inch of the specified or theoretical length.

2-1.04. Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	None
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

2-2. ACCESSORIES.

2-2.01. Manual Operators. Valves shall be furnished with manual operators to allow valve operation when electrical power is off.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

Section 40 05 93

COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 – GENERAL

1-1. SCOPE. This section covers single and three-phase, small (fractional) and medium (integral) horsepower, alternating current motors rated 500 horsepower and less (NEMA MG1).

Motors shall be designated and coordinated with the driven equipment and shall be located as indicated on the Drawings.

1-2. GENERAL. Motors furnished under driven equipment Specification sections shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Design-Builder.

Where applicable, individual motor data sheets have been developed which specify additional requirements for specific motors.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all motors, unless otherwise specified. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Governing Standards. Motors furnished under this section shall be designed, constructed, and tested in accordance with the latest version of NEMA MG 1, NEMA MG 10, and IEEE 112, Test Method B.

1-2.04. Nameplates. All motor nameplate data shall conform to NEMA MG 1 requirements.

1-3. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Motors

Name of manufacturer.
Type and model.
Type of bearing and method of lubrication.
Rated size of motor, hp [kW], and service factor.
Temperature rise and insulation rating.
Full load rotative speed.
Net weight.
Efficiency at full, 3/4, and 1/2 load.
Full load current.
Locked rotor current.
Space heater wattage, where applicable.
Motor temperature switch data, where applicable.
Motor Shaft Grounding Ring data, where applicable.
RTD data, where applicable.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

Operation and maintenance manuals shall include the following:

a. Assembly, installation, alignment, adjustment, and checking instructions.

b. Lubrication and maintenance instructions.

c. Guide to troubleshooting.

d. Parts lists and predicted life of parts subject to wear.

e. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

f. Test data and performance curves, where applicable.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Service conditions for motors shall be as specified in the driven equipment Specification sections. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or service environment. The motors shall be designed for the site elevation and ambient temperatures indicated in the Meteorological and Seismic Design Criteria section.

Unless specified otherwise, all motors shall be designed for full voltage starting and to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Motors utilizing a reduced-voltage, autotransformer starter shall be capable of reduced-voltage starting at a 65 percent tap setting.

Motors utilizing a reduced voltage solid state starter shall be capable of starting at 50% of the specified voltage.

When powered from a variable frequency drive (VFD), motors shall be inverter duty and specifically selected for service with an adjustable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by AFDs shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

The number of starts per hour for motors shall be rated for the load cycling requirements of NEMA MG 10.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Unless otherwise specified in the attached motor data sheet(s), design and construction of each general-purpose motor shall be as specified herein. Motor voltage, frequency, speed, service factor, and insulation class shall be as follows.

Motor voltage.	460, 3 phase for ½ horsepower and larger, 120, single phase for smaller than ½ horsepower
Frequency.	60 Hz
Speed.	Constant speed
Service factor.	1.0, except for VFD driven motors which shall be 1.15
Insulation class and temperature rise above 40° C design ambient (by resistance method.	Class F with 90° C rise at 1.15 SF
Enclosure.	Totally enclosed fan cooled
Main conduit box sized to include.	Main motor leads and space heater leads where space heaters are specified

2-2.01. Nameplate Horsepower. Motor nameplate horsepower [kW] shall be equal to or greater than the maximum load imposed by the driven equipment.

2-2.02. Enclosures. All motors shall be self-ventilated. All self-ventilated open type motors, including those with dripproof, splashproof, and weather protected enclosures, and the fan covers of totally enclosed fan cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.

2-2.02.01. Totally Enclosed Motors. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Frames, bearing brackets, external terminal housings, and fan covers for fan cooled motors shall be cast iron. External cooling fans for fan cooled motors shall be fabricated of brass, bronze, aluminum alloy containing not more than 0.2 percent copper, malleable iron, or plastic. All plastic fans shall be fabricated of a reinforced thermosetting plastic and shall be UL approved.

2-2.02.02. Outdoor Motors. Outdoor motors shall have NEMA weather protected enclosures. All exposed metal surfaces shall be protected, where practical, with a corrosion resistant polyester coating. Exposed uncoated surfaces shall be of a corrosion resistant metal. Enclosure exterior and interior surfaces, air gap surfaces, and windings shall be protected with a corrosion resistant polyester, polyurethane or epoxy coating.

2-2.02.03. Motors for Hazardous Locations. Motors for hazardous locations shall be in accordance with the NEC and of the correct type enclosures for the particular service as specified in NEMA MG 1. Motors shall meet the requirements of UL 674.

2-2.02.04. Encapsulated Windings. Where specified in the motor data sheet(s), motors shall be provided with encapsulated windings meeting the requirements of NEMA MG1-1.27.2.

2-2.02.05. Severe Duty Chemical Service Motors. Where specified in the motor data sheet(s), motors shall be provided with special corrosion-resistant finish and encapsulated windings meeting the requirements of NEMA MG1-1.27.2 and IEEE 841.

2-2.03. Main Conduit Boxes. The main conduit box shall be in accordance with NEMA MG 1. The main conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90-degree increments. A gasket shall be furnished between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line Drawings.

The main conduit box shall be sized for all indicated accessory leads.

Motors furnished in NEMA 320 frame series and larger shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.

2-2.04. Leads. Motor power leads shall be wired into the main conduit box. Unless otherwise specified, space heater leads shall be wired into the main conduit box. All motor leads and their terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Each lead marking shall be visible after taping of the terminals.

All motors rated 100 horsepower [74 kW] and larger, and all vertical motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

Leads for dual-voltage rated or for multispeed motors shall be easily connected or reconnected in the main conduit box for the operating voltage or for the specified speeds. Permanent instructions for making these connections shall be furnished inside the main conduit box or on the motor frame or nameplate.

2-2.05. Terminals. Cable type leads shall be provided with compression type connectors.

2-2.06. Grounding Connections. All motors shall be furnished with a ground connection.

2-2.07. Bearings. All bearings shall be self-lubricating, shall have provisions for relubrication, and shall be designed to operate in any position or at any angle.

All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy relubrication from the outside of the motor while the motor is in service, as necessary.

2-2.07.01. Insulated Bearings. Motors over 100 horsepower controlled by an adjustable frequency drive shall be furnished with one insulated bearing. The insulated bearing shall be installed on the non-drive end of the motor.

2-2.08. Rotors. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced to 0.08 in./sec [2.03 mm/s] or less.

2-2.09. Shafts. Shafts shall be furnished with corrosion resistant treatment or shall be of a corrosion resistant material.

2-2.10. Torque Characteristics. Motors rated 200 horsepower [149 kW] and less shall have torques and locked-rotor current in accordance with NEMA MG 1, Part 12.

2-2.11. Motor Space Heaters. Outdoor motors 1 horsepower and larger shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply.

2-2.12. Temperature Sensing Devices. Each motor controlled by an adjustable frequency drive shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amps at 120 volts ac. The contacts shall be wired in series with the end leads brought out to the motor terminal box.

Motors shall be furnished with a pair of resistive temperature devices (RTDs) placed in each phase winding to sense winding temperature. Bearing RTDs complete with detector head and holder assemblies shall be furnished in accordance with the applicable requirements of ISA MC96.1 and IEEE 119. All RTDs shall be 100 ohm, platinum type, and shall be connected with a twisted shielded triad to the motor protection relay.

An auxiliary conduit box shall be provided for termination of RTD or temperature switch wiring.

2-2.13. Motor Shaft Grounding Ring. Each motor controlled by an adjustable frequency drive shall be furnished with a maintenance free, conductive micro fiber, shaft grounding ring with circumferential micro fibers to discharge electrical shaft currents within the motor. Motor shaft grounding ring shall be installed on the drive end on the motor shaft. Shaft grounding ring shall be installed by the motor's manufacturer in accordance with grounding ring manufacturer's recommendations.

2-2.14. Assembly. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

2-2.15. Efficiency. Unless otherwise specified in the attached motor data sheet(s), motors shall be premium efficiency type and shall have a NEMA nominal efficiency nameplate value equal to or greater than values indicated in the following table. Efficiency shall be determined in accordance with IEEE 112, Test Method B.

Vertical motors shall have efficiency values equal to or greater than those indicated in the following table minus 0.50.

Motor		Nominal Efficiency Values				Nominal Efficiency Values			
kW	hp	Open Drip Enclosure				TEFC Enclosure			
		3600 rpm	1800 rpm	1200 rpm	900 rpm	3600 rpm	1800 rpm	1200 rpm	900 rpm
0.7	1	84.0	85.5	82.5	75.0	77.0	85.5	82.5	75.5
1.1	1.5	84.0	86.5	86.5	78.0	84.0	86.5	87.5	80.0
1.5	2	85.5	86.5	87.5	86.5	85.5	86.5	88.5	85.5
2.2	3	85.5	89.5	88.5	89.5	87.0	89.5	89.5	86.5
3.7	5	86.5	89.5	89.5	89.5	88.5	89.5	89.5	85.5
5.6	7.5	88.5	91.0	90.2	88.5	90.0	91.7	91.0	86.5
7.5	10	89.5	91.7	91.7	91.0	91.0	91.7	91.0	91.0
11.2	15	90.2	93.0	91.7	91.0	91.0	92.4	92.0	91.0
14.9	20	91.7	93.0	92.4	92.0	92.0	93.0	92.0	91.0
18.7	25	92.4	93.6	93.0	92.0	92.0	93.6	93.0	91.0
22.4	30	93.0	94.1	93.6	93.0	92.4	93.6	93.0	93.0
29.8	40	93.0	94.1	94.1	93.0	92.4	94.1	94.1	93.0
37.3	50	93.0	94.5	94.1	93.0	93.0	94.5	94.1	93.0
44.8	60	93.6	95.0	94.5	94.0	93.6	95.0	94.5	93.0
56	75	94.0	95.0	95.0	94.0	93.6	95.4	95.0	94.0
74.6	100	94.5	95.4	95.0	95.0	94.1	95.4	95.0	94.0
93.2	125	95.0	95.4	95.0	95.0	95.0	95.4	95.0	94.0
112	150	95.0	95.8	95.4	95.0	95.0	95.8	95.8	94.0
149	200	95.4	95.8	95.4	95.0	95.4	96.2	95.8	94.1
186	250	95.0	95.8	95.4	95.0	95.8	96.2	95.8	94.5
224	300	95.4	95.8	95.4		95.8	96.2	95.8	
261	350	95.4	95.8	95.4		95.8	96.2	95.8	
298	400	95.8	95.8	95.8		95.8	96.2	95.8	

Motor		Nominal Efficiency Values				Nominal Efficiency Values			
kW	hp	Open Drip Enclosure				TEFC Enclosure			
		3600 rpm	1800 rpm	1200 rpm	900 rpm	3600 rpm	1800 rpm	1200 rpm	900 rpm
336	450	95.8	96.2	96.2		95.8	96.2	95.8	
373	500	95.8	96.2	96.2		95.8	96.2	95.8	

2-3. ACCESSORIES.

2-3.01. Special Tools and Accessories. Motors requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor shall be provided with lifting eyebolts or lugs and appropriate fittings for adding bearing lubricant. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2-4. ANCHORS. Contractor shall furnish suitable anchors for each item of equipment as required for driven equipment.

2-5. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits as required by NEMA MG 1. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3-1. INSTALLATION. Each motor shall be installed in accordance with the Equipment Installation section.

End of Section

Section 40 42 11

MECHANICAL INSULATION

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of insulation, jackets, and accessories for the following mechanical systems:

- piping
- ductwork
- equipment

Building insulation materials are specified in other sections. Insulation for mechanical equipment which is to be applied at the factory prior to shipment is specified in the individual equipment sections.

Electrical heat tracing for piping shall be as specified in the Electrical section.

1-2. GENERAL. Materials furnished and installed under this section shall be in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Design-Builder.

1-2.01. Coordination. Contractor shall be responsible for coordinating the installation of insulation with the installation of the items or systems to be insulated. Each item or system shall be tested and accepted by Design-Builder before installation of the insulation materials.

Contractor shall verify that each component of the insulation systems is compatible with all other parts of the system; that all insulation materials are appropriate for the intended applications; and that all necessary devices and accessories have been provided.

All insulation of the same class shall be the product of a single manufacturer; however, all the insulation types need not be the products of one manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL, NFPA, and ASTM safety requirements.

1-2.04. Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1-2.05. Surface Burning Characteristics. Insulation, jackets, tapes, and adhesives to be used indoors shall have a composite flame spread rating not to exceed 25 and a composite smoke developed rating of 50 when tested by UL 723, NFPA 255, or ASTM E84. All testing shall be done on materials of the same densities and installed thicknesses as the materials being installed. Insulation materials which have been treated with a flame retardant additive to meet the required flame spread and smoke developed ratings are not acceptable.

1-2.06. Painting and Identification. Field painting and identification shall be as specified in the Protective Coatings section.

Piping systems with electrical heat tracing shall have warning labels attach to the outside of the pipe thermal insulation weather barrier to indicate the presence of electric heat tracing. Labels shall be located every 10 feet of pipe, alternating on either side. The labels shall be black on yellow, weatherproof, mylar, with pressure sensitive adhesive and at least 2 inches by 6 inches minimum.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. A complete list of materials and catalog cuts, together with detailed specifications, materials performance data, installation instructions, parts, devices, and accessories furnished, shall be submitted in accordance with the Submittals Procedures section. Information shall include certified test results to show compliance with UL, NFPA, and ASTM safety requirements.

1-4. QUALITY ASSURANCE.

1-4.01. Manufacturer Experience. A manufacturer shall have furnished material of the type specified which has been in successful operation for not less than the past 5 years.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2-2. MATERIALS. Insulation, vapor retarders, and field applied jackets shall be installed to cover piping, ductwork, equipment, fittings, and appurtenances as indicated in the Insulation Schedule.

2-2.01. Pipe Insulation.

2-2.01.01. Type PMF1 Insulation. Type PMF1 mineral fiber pipe insulation shall be Johns Manville "Micro-Lok", Knauf "Pipe Insulation" or Owens-Corning.

Type PMF1 pipe insulation shall be a one-piece molded glass fiber material with all-purpose jacket. The all-purpose jacket shall be factory-applied, fiberglass reinforced vapor barrier type, with white kraft bonded to aluminum foil and self sealing adhesive lap. The insulation shall be suitable for a temperature range of 0°F to 850°F [-18°C to 454°C], shall have a maximum thermal conductivity (k) of 0.24 Btu in/hr ft^2 °F at 75°F [0.035 W/m °C at 24°C], and shall conform to ASTM C547.

2-2.01.02. Type PMW1 Insulation. Type PMW1 high temperature mineral wool pipe insulation shall be Rock Wool Manufacturing Company “Delta-PC”.

Type PMW1 pipe insulation shall be a high temperature, sectional or segmented mineral wool forms with thermosetting binder suitable for temperatures up to 1200°F [649°C], and shall be provided in multiple layers. Fittings and valves shall be insulated with factory-made molded fiber fittings or built-up sections of pipe covering. The insulation shall conform to ASTM C547.

2-2.02. Duct Insulation.

2-2.02.01. Type DMF1 Insulation. Type DMF1 semi-rigid type duct insulation shall be Johns Manville "800 Series Spin-Glas", Knauf "Insulation Board", or Owens-Corning “Fiberglas 705”.

Type DMF1 exterior insulation for rectangular ductwork shall be a semirigid, 6 pounds per cubic foot [96 kg/m^3] density fiberglass material with a factory-applied all service jacket. Insulation suitable for temperatures of up to 150°F [66°C], and shall have a maximum thermal conductivity (k) of 0.23 Btu in/hr ft2 °F at 75°F [0.033 W/m °C at 24°C]. The insulation shall conform to ASTM C612.

2-2.02.02. Type DMF2 Insulation. Type DMF2 flexible type duct insulation shall be Johns Manville "Microlite", Knauf "Friendly Feel Duct Wrap", or Owens-Corning “SOFTR All-Service Duct Wrap”.

Type DMF2 exterior insulation for round ductwork shall be 1 lb per cubic foot [16 kg/m^3] density flexible fiberglass duct wrap with factory-applied foil-scrim-kraft facing. Insulation suitable for temperatures of up to 250°F [121°C], and shall have a maximum thermal conductivity (k) of 0.27 Btu in/hr ft2 °F at 75°F [0.039 W/m °C at 24°C]. The insulation shall conform to ASTM C553.

2-2.03. Equipment Insulation.

2-2.03.01. Type EMF1 Insulation. Type EMF1 equipment insulation shall be Johns Manville "800 Series Spin-Glas", Knauf "Insulation Board", or Owens-Corning “Fiberglas 705”.

Type EMF1 equipment insulation shall be rigid mineral fiber insulation board with a density of 6 pounds per cubic foot [96 kg/m^3] and a factory-applied foil-scrim-kraft facing. Insulation suitable for temperatures of up to 150°F [66°C], and shall have a maximum thermal conductivity (k) of 0.23 Btu in/hr ft2 °F at 75°F [0.033 W/m °C at 24°C]. The insulation shall conform to ASTM C612.

2-2.03.02. Type EMW1 Insulation. Type EMW1 equipment insulation shall be Rock Wool Manufacturing Company “Delta-12 Mineral Wool Board".

Type EMW1 equipment insulation shall be high temperature mineral wool board with a thermosetting binder suitable for temperatures up to 1200°F [649°C] and shall have a density of 12 pounds per cubic foot [192 kg/m^3]. The insulation shall conform to ASTM C592.

2-3. ACCESSORIES.

2-3.01. PVC Insulation Jackets. PVC insulation jackets for piping systems shall be furnished and installed as specified herein and indicated on the Drawings.

All fittings in piping systems insulated with mineral fiber shall be jacketed with a polyvinyl chloride (PVC) jacketing material. Piping systems where indicated to have PVC jackets shall be jacketed with the same PVC jacketing material. Jackets for fittings shall be one piece, factory molded to the contour of the fitting. The PVC jacket and fitting covers shall have a minimum thickness of 0.020 inches [0.51 mm] when installed indoors and 0.030 inches [0.76 mm] when installed outdoors. PVC jacketing shall be Johns Manville "Zeston 2000 Series".

PART 3 - EXECUTION

3-1. INSTALLATION.

3-1.01. General. Contractor shall install all insulation materials as specified herein for the piping systems, ductwork, and equipment that are not factory

insulated. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried. All work shall be performed within the temperature ranges recommended by the insulation product manufacturer. Insulation shall be kept clean and dry and shall remain in the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label with the name of the manufacturer and description of materials.

Seams of exposed insulation and jackets shall be in the least visible location.

3-1.02. Piping Insulation.

3-1.02.01. Type PMF1 Insulation. Pipe insulation, vapor retarders, and field applied jackets shall be installed to cover system piping, fittings, and appurtenances. Insulation shall be full factory unit lengths using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. End joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.

Insulated piping conveying fluids at lower than ambient temperatures shall be jacketed with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and shall be sealed with vapor barrier coating. The vapor barrier coating shall be applied at intervals not exceeding 15 feet [4.6 m] for straight runs and not more that 6 inches [150 mm] from fittings. Fibrous insulation laps and butt strips that are not self-sealing shall be secured with adhesive and stapled. Staples and seams shall be coated with vapor barrier material.

On piping 2 inches [50 mm] and larger where the insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be of the same thickness and contour as the adjacent insulation and installed to maintain a continuous vapor barrier through the support. The insert shall be constructed of wood or heavy density insulating material suitable for the system operating temperatures.

3-1.02.02. Type PMW1 Insulation. The insulation shall be installed in layers to obtain the specified thickness. Joints and seams between insulation sections or segments shall be tight and shall be staggered between layers. The insulation shall be shall be fastened with stainless steel wire loops on 6 inch [150 mm] centers embedded into the outer layer. All cracks, voids, and depressions shall be filled with insulating cement suitable for the system operating temperatures. The surfaces to receive outer coverings shall be smooth and uniform. Flanges and expansion joints in exhaust piping shall not be insulated.

3-1.02.03. Type PFC1 Insulation. Pipe insulation shall be installed to cover all pipe, fittings, and appurtenances with all seams and joints sealed by a factory or field applied adhesive. Insulation at fittings and appurtenances shall be carefully formed and fitted. Insulation at elbows shall be mitered using segments of pipe insulation.

3-1.03. Duct Insulation. Insulation for ducts indicated on the Drawings as wrapped shall be installed as specified herein and indicated on the Drawings. Duct insulation shall be continuous through hangers and penetrations, except firewall penetrations but shall be interrupted at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their functioning and/or replacement. Insulation jackets shall be continuous across seams, reinforcement, and projections.

Insulation on ducts conveying air at temperatures below 60°F [16°C] shall be installed with a continuous vapor barrier seal. Staples and joints shall be sealed with a vapor barrier coating.

3-1.03.01. Type DMF1 Insulation. Type DMF1 semirigid insulation shall be secured to all four sides of the duct with mechanical fasteners, spaced not more than 12 inches [305 mm] apart and not more than 3 inches [76 mm] from the edges of the insulation joints. At least two rows of fasteners shall be provided for each side of 12 inch [305 mm] and larger ducts, and one row for each side of ducts smaller than 12 inches [305 mm]. All joints in the insulation shall be sealed with 3 inch [76 mm] wide joint sealing tape or 4 inch [102 mm] wide strips of jacket material secured with adhesive and staples.

3-1.03.02. Type DMF2 Insulation. Type DMF2 flexible insulation shall be installed with waterproof, fire-retardant adhesive. Insulation jackets shall overlap at least 2 inches [51 mm] and shall be secured under the overlap with adhesive and stapled on 4 inch [102 mm] centers.

3-1.04. Equipment Insulation. Insulation for equipment shall be installed as specified herein and indicated on the Drawings. Equipment insulation shall be installed and fastened as recommended by the manufacturer.

Equipment insulation shall be installed in as closest contact possible with the equipment surface and shall be secured with studs, pins, clips, adhesives, wires, or bands. Pumps may be insulated by forming a box around the pump housing. Seams shall be sealed with joint sealing tape. A smooth coat of insulation cement shall be applied over the insulation except at removable sections. On equipment with surface temperatures lower than 60°F [16°C], two coats of vapor barrier coating shall be applied.

Equipment insulation shall be applied with interruptions for access to manholes, flanges, and other openings without disturbing the insulation. Boxouts with beveled and sealed edges shall be provided around code stamping symbols and nameplates.

3-1.05. PVC Jacketing. PVC jacketing for piping systems shall be installed as specified herein and indicated on the Drawings. End joints and longitudinal seams on piping systems conveying fluids at lower than ambient temperatures shall be vapor-sealed, and covered with vapor-barrier tape to ensure a continuous vapor seal. Fittings shall be insulated with glass fiber material.

3-2. INSULATION SCHEDULE.

INSULATION SCHEDULE				
Service	Size Inches [mm]	Mechanical Insulation		Notes
		Type	Thickness Inches [mm]	
PIPING - INDOOR (CONCEALED OR EXPOSED)				
Compressed Air	All	PMF1	1 [25]	(1)
Condensate Drain	All	PMF1	1 [25]	(3)
Engine Exhaust	All	PMW1	Note (7)	(1)
NaOH, $FeCl_3$ Without Heat Tracing	All	PMF1	1 [25]	(1)
Non-Potable Cold Water	Up to 3 [80] 4 [100] & larger	PFC1 PFC1	3/4 [20] 1 [25]	(3) (3)
Potable Cold Water	Up to 3 [80] 4 [100] & larger	PFC1 PFC1	3/4 [20] 1 [25]	(3) (3)
Potable Hot Water	Up to 1-1/4 [32] 1-1/2 [40] & larger	PMF1 PMF1	1 [25] 1-1/2 [40]	(9) (9)

Process Air	All	PMF1	1 [25]	(1)
Sludge	Up to 2 [50] Larger than 2 [50]	PMF1 PMF1	1-1/2 [40] 2 [50]	(2) (2)
PIPING - OUTDOOR (EXPOSED)				
Compressed Air	All	PMF1	1 [25]	(1), (4)
NaOH, $FeCl_3$ Without Heat Tracing at 0°F+	All	PMF1	2 [50]	(1)
Process Air	All	PMF1	1 [25]	(1)
Sludge	Up to 2 [50] Larger than 2 [50]	PMF1 PMF1	1-1/2 [40] 2 [50]	(1) (1)
Piping with Heat Tracing	All	PMF1	1-1/2 [40]	(1)
DUCTWORK				
Rectangular	Within conditioned space All other indoor locations	DMF1 DMF1	1 [25] 2 [50]	(6) (5), (6)
Round	Within conditioned space All other indoor locations	DMF2 DMF2	2 [50] 3 [75]	(6) (5), (6)
EQUIPMENT				
Engine Silencer	All	EMW1	Note (7)	(1)
Mechanical Insulation Types:	FC - Flexible Cellular MF - Mineral Fiber MW - Mineral Wool			

Notes:

(1) Aluminum jacket.

(2) PVC jackets shall be provided on exposed portions of insulated piping located less than 8 feet [2.4 m] above finished floor. On all other portions of the insulated piping system PVC jackets shall be provided only for fittings.

(3) Insulation shall be provided for portions of the piping system which pass through space above finished ceilings or is exposed above equipment, electrical panels, or cabinets.

(4) Insulation shall be provided for exposed portions of the piping system located less than 8 feet [2.4 m] above the finished floor or grade.

(5) Insulation shall be provided for outside air plenums and ducts that are located upstream of the heating coil or pass through unheated spaces after the heating coil, unless indicated to be internally lined.

(6) Insulation shall be provided for outside air plenums and ducts, air conditioning supply and return ducts, and dehumidifier reactivation air discharge ducts, unless indicated to be internally lined.

(7) Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F [66°C].

(8) The underside of all roof drains shall be insulated to a 1 foot [300 mm] radius from the center of the drain. All roof drain piping within 4 feet [1.2 m] of the drain shall be insulated.

(9) Includes 8 feet [2.4 m] of the cold water inlet piping to the water heater storage tank.

Unless otherwise indicated in the insulation schedule, all mechanical piping, ductwork, equipment, and accessories with an operating temperature in excess of 140°F or below 60°F shall be insulated.

End of Section

Section 40 61 11

INSTRUMENTATION AND CONTROL SYSTEM

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and installation of an instrumentation and control system designated as the Plant Control System (PCS).

The system shall be furnished as specified, complete with all software, human machine interface (HMI) hardware, input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation. The PCS is comprised of the Supervisory System (Servers and workstation computers and the Process System (programmable logic controllers (PLCs), Remote I/O (RIO) and packaged systems' PLCs). The PCS will be integrated into the City-wide Supervisory Control and Data Acquisition (SCADA) System.

Vendors/Equipment Suppliers for the procurement packages are also responsible for meeting the requirements within this section as applicable to their instrumentation and control system.

1-1.01. Associated Sections. This section also includes the equipment and services specified in the following sections. Not every section listed below is provided with the supplier request for proposal package as they are not all applicable.

Section 40 62 00	COMPUTER SYSTEM HARDWARE
Section 40 64 00	PROGRAMMABLE LOGIC CONTROLLERS
Section 40 64 01	VENDOR STANDARD PROGRAMMABLE LOGIC CONTROLLERS
Section 40 66 11	NETWORK SYSTEMS
Section 40 66 33	METALLIC AND FIBER OPTIC COMMUNICATION CABLE AND CONNECTORS
Section 40 67 11	PANELS, CONSOLES, AND APPURTENANCES
Section 40 68 16	COMPUTER SYSTEM SOFTWARE
Section 40 68 83	SOFTWARE CONTROL BLOCK DESCRIPTIONS
Section 40 69 13	UNINTERRUPTIBLE POWER SUPPLY
Section 40 71 00	FLOW INSTRUMENTS
Section 40 72 00	PRESSURE AND LEVEL INSTRUMENTS

Section 40 74 00 TEMPERATURE INSTRUMENTS

Section 40 75 00 PROCESS ANALYTICAL INSTRUMENTS

Section 40 78 00 PANEL MOUNTED INSTRUMENTS

Section 40 79 11 MISCELLANEOUS INSTRUMENTS

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Instrumentation and Control System Supplier.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment. The drawings also delineate scope of supply with asterisks (*), boxes and callouts for equipment within the scope of another system suppliers. The input/output (I/O) lists are attached as an appendix to the Programmable Logic Controllers section and are also indicated on the P&I Drawings.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings and instrument device schedule attached this section.

1-2.03. Codes, Permits and Agency Approvals. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where mandated by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories (UL) or if UL is not available another nationally recognized test laboratory (NRTL). Design-Builder shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.

1-2.04. Supplier’s Qualifications. Equipment and software furnished under this section and under other related sections listed in the Scope paragraph above shall be designed, coordinated, and supplied by a single manufacturer or supplier, hereinafter referred to as the System Supplier. The System Supplier shall be regularly engaged in the business of supplying computer-based monitoring, control, and data acquisition systems. The Design-Builder shall utilize the services of the System Supplier to coordinate all control system related

items, to check-out and calibrate instruments, and to perform all testing, training, and startup activities specified to be provided.

The System Supplier shall have the following minimum qualifications:

- The supplier shall maintain a design office staffed with qualified technical design personnel.
- The supplier shall maintain competent and experienced service personnel to service the hardware and software furnished for this project.
- The supplier shall have as a minimum 5 years of experience in the design, coordination and supply of computer-based monitoring, control, and data acquisition systems.

1-2.05. Coordination. Systems supplied under this section shall be designed and coordinated by System Supplier for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment. All equipment shall be designed and installed in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

1-2.06. Related Equipment and Materials. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.

1-2.07. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with System Supplier's equipment drawings and shall match the tag numbers used on the Drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1-3. GENERAL REQUIREMENTS. The drawings and specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by System Supplier, details of such departures and the reasons shall be submitted to Design-Builder for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

The specifications describe the minimum requirements for hardware and software. Where System Supplier's standard configuration includes additional items of equipment or software features not specifically described herein, such

equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

1-3.01. Governing Standards. Equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 - Class A, and NEMA ICS-1-109.60.

1-3.02. Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The System Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Design-Builder. At least three feet of clear access space shall be provided in front of all instrumentation and control system components.

1-3.03. Workmanship and Materials. System Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except for testing.

1-3.04. Corrosive Fluids. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials. System Supplier shall submit certification that the instrument manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.

1-3.05. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

1-3.06. Programming Devices. A programming or system-configuring device shall be provided for systems that contain any equipment that requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of start-up.

1-3.07. Instrument Cleaning. Instruments to be utilized in oxygen, ozone, or similar service shall be cleaned for oxygen service, labeled appropriately, and

bagged or packaged as necessary to ensure the instrument will remain suitable for insertion in the process during installation. Any special mounting or installation requirements associated with such instruments shall be detailed on tags attached to the instrument.

1-4. SUBMITTALS. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the Submittal Procedures section and the Schedule of Submittals. Submittal data shall be grouped and submitted in three separate stages as indicated in the Schedule of Submittals and herein. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.

1-4.01. First Stage Submittal. The first stage submittal shall include the following items.

a. A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by System Supplier and this specification.

b. Product catalog cut sheets on all hardware and software items, clearly marked to show the model number, optional features, and intended service of each device.

c. A brief, concise description of the proposed system, including major hardware and software components and personnel training.

d. A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships.

e. Drawings showing floor and wall space or desktop area requirements for all equipment items, including allowances for door swings and maintenance access.

f. Environmental and power requirements, including heat release information for each equipment item.

g. Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

h. A copy of the proposed software licenses for all software associated with the system.

i. Outline for training classes.

j. Additional Requirements identified in other sections.

1-4.02. Second Stage Submittal. Before any equipment is released for shipment to the site and before factory testing is scheduled, the following data shall be submitted.

a. Detailed functional descriptions and control philosophy of all software modules specified and furnished as part of System Supplier's standard system. The descriptions shall indicate available modes of control, permissive to be met before auto sequences commence or continue, description of automatic startup and shutdown, operator adjustable set points with ranges and defaults, alarm and shutdown conditions. The descriptions shall be identified with the applicable specification paragraph.

b. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall be to scale and shall include overall dimensions, metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

c. Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If panel terminal designations, inter-device connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the site.

d. Fiber termination diagrams to show all fiber terminations at fiber patch panels and final termination at equipment. Fiber termination diagrams shall show individual fiber type (single or multimode), fiber core/cladding dimensions, fiber colors, circuit identifications, and type of terminator.

e. Review of drawings submitted prior to the final determination of related equipment shall not relieve System Supplier from supplying systems in full compliance with the specific requirements of the related equipment.

f. Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal.

g. Proposed lesson plans or outlines for all training courses specified herein, including schedule, instructors' qualifications and experience, and recommended prerequisites.

h. Standard system engineering and user manuals describing the use of the system and application programming techniques for creating reports, graphics, database, historical records, and adding new process I/O nodes to the system.

i. Additional Requirements identified in other sections.

1-4.03. Third Stage Submittal. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted. Additional requirements are identified in other specification sections.

1-5. PREPARATION FOR SHIPMENT. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Design-Builder.

Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

Instrument shipment and storage requirements shall be coordinated with Design-Builder prior to shipment. Design-Builder shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1-6. DELIVERY, STORAGE, AND SHIPPING. The System Supplier shall coordinate with the Design-Builder and shall deliver equipment for installation in accordance with the general Terms and Conditions of this procurement package.

1-7. SPARE PARTS. Spare parts and consumable items are specified in other sections. The System Supplier shall provide spare parts per the general Terms and Conditions.

1-7.01. Packaging. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.

1-7.02. Replacement. Design-Builder may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

PART 2 - PRODUCTS

2-1. GENERAL REQUIREMENTS. All equipment furnished under each section referenced in SCOPE is a part of this section and shall be selected by System Supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review.

2-1.01. Standard Products. The systems furnished shall be standard products. Where two or more units of the same type of equipment are supplied, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.

To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.

Where redundant hardware is provided, the system shall be capable of performing all specified functions, without reconfiguring hardware or software, with only one device of each category in service.

2-2.01. Factory Assembly. Equipment shall be shipped completely factory assembled, except where its physical size, arrangement, configuration, or shipping and handling limitations make the shipment of completely assembled units impracticable.

2-3. POWER SUPPLY AND INSTRUMENT SIGNAL. Power supply to all control system equipment shall be 120 volts, 60 Hz, single phase. System Supplier shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system from the power supply receptacles and junction boxes indicated on the Drawings. Power distribution hardware shall include cables and branch circuit overcurrent protection installed in accordance with the electrical section.

Unless otherwise indicated, power supply to the instrumentation shall be 24 volts dc to the greatest extent possible. For instruments not capable of 24 volts dc power; unregulated 120 volts, 60 Hz, single phase power shall be utilized. Unless otherwise indicated, all transmitted electronic analog instrument signals shall be 4-20 mA dc and shall be linear with the measured variable.

2-3.01. Facility Distribution System. Equipment not indicated to be powered from an uninterruptible power source shall be suitable for being supplied from the facility distribution system and shall be capable of withstanding voltage variations of $\pm$10 percent and harmonics up to the limits of IEEE 519 without affecting operation. System Supplier shall provide voltage conditioning or filtering equipment if necessary, to meet the requirements specified.

2-3.02. Power Supplies. Power supplies for voltages other than those listed above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected.

2-3.03. Surge Withstand. All equipment shall meet all surge withstand capability tests as defined in ANSI C37.90 without damage to the equipment.

2-3.04. Uninterruptible Power Supply. An uninterruptible power supply (UPS) shall be furnished hereunder to power the equipment indicated on the Drawings or will be furnished under another section. System Supplier shall be responsible for coordinating the size of the UPS unit with the equipment furnished hereunder, and shall advise Design-Builder if a unit of higher capacity is necessary.

2-4. SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS. The equipment provided for the instrumentation and control system shall be suitable for the service conditions specified in the attached equipment sections.

All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.

2-4.01. Ambient Temperature and Elevation. All system equipment located in air-conditioned rooms shall be suitable for operation in ambient temperatures from 10°C to 35°C and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non-air-conditioned indoor areas shall be suitable for an ambient temperature range of 0°C to 50°C and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range -20°C to 60°C and a relative humidity of 5 to 100 percent. Heaters and air conditioning/cooling equipment shall be provided where essential to maintain equipment within its manufacturer-recommended operating ranges.

All equipment and instruments shall be designed to operate at the site elevation as defined in the Seismic and Meteorological Design Criteria section.

2-4.02. Deleterious Effects. All system equipment will be installed in areas without anti-static floor construction and without any provisions for control of particulates or corrosive gases other than ordinary office-type HVAC filtering. System Supplier shall furnish any additional air cleaning equipment, anti-static chair pads, or other protective measures necessary for proper operation of the system.

All input/output hardware shall meet or exceed, without false operation, all requirements of NEMA ICS-1-109.60, Electrical Noise Tests.

2-4.03. Noise Level. The equivalent "A" weighted sound level for any system equipment located in the control room, except printers, shall not exceed 35 dBA. The sound level for printers shall not exceed 65 dBA. Sound reduction enclosures shall be provided where necessary to comply with these limits.

2-4.04. Lightning Protection. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.

2-4.04.01. Grounding. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the Drawings shall be modified as recommended by System Supplier.

2-4.04.02. Surge Suppressors. Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) or silicon junction type, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:

a. All 120 VAC power connections to PLCs, RIOs, instruments and control room equipment. Surge arresters shall be Transtector "ACP-100-HW Series", Power Integrity Corporation “ZTA Series”, Phoenix Contact “Mains PlugTrab”, or MCG Surge Protection “400 Series”.

b. All connections to coaxial-based networked equipment (including CCTV, CATV, Ethernet, Arcnet, and satellite) where any part of the circuit is outside of the building envelope. Surge arresters shall be Telematic “VP08”, Transtector CCTV-PTZ Series”, Phoenix Contact “CoaxTrab Series”, or Northern Technologies “TCS-CP3 Series”.

c. All analog signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede or interfere with the use of smart transmitter calibration/communication. Protection devices located near the transmitter shall be Telematic “TP48.” Protection devices in control panels shall be Transtector “PDS Series or FSP Series”, Telematic “SD Series”, Phoenix Contact “PipeTrab Series”, or Citel “BP1-24.”

d. All metallic pair (twisted and untwisted) conductor local area network and data highway termination points, where any part of the data highway cable is routed outside of the building envelope. Single-port protective devices shall be Phoenix Contact “PlugTrab Series”, Transtector “FSP” Series”, or Telematic “NP Series.”

e. All serial, PLC data highway, and remote I/O network termination points where any part of the circuit is routed outside of the building envelope. Surge protection devices shall be Transtector “DRDC Series” (RS-232); Transtector “FSP Series” (RS-422), Phoenix Contact “PlugTrab Series” or Citel “E280 Series”.

f. All telephone lines at points of connection to the system. Protection devices for dial-up circuits shall be Transtector “TSJ Series”, Telebyte “Model 22PX”, Citel “BP1-T”, or equal. Protection devices for full

period circuits shall be Transtector “LMP Series”, Northern Technologies “DLP-S Series”, Phoenix Contact “TeleTrab Series”, or Circuit Components, Inc. “SPR-TM Series.”

2-5. SOFTWARE DOCUMENTATION. System Supplier shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the optical media backup. Software documentation shall consist of the following principal items.

a. One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.
b. Two complete back-up copies of system and application software in executable format on optical media compatible with the system furnished.
c. Three sets of user reference manuals for all standard system and application software.
d. One set of user reference manuals for all operating system software.
e. Three sets of printed as-built reference documentation for any special software provided specifically for this contract.
f. For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. One set of this documentation shall be supplied for each and every piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2-6. SOFTWARE LICENSE. All software programs supplied as a standard part of System Supplier’s products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict Owner from using the software on the system provided hereunder or its replacement. Owner shall have the right to make copies of the software for use on the system provided. Specific requirements of System Supplier’s software license are subject to review and approval by Owner and Design-Builder.

2-7. INSTALLATION TEST EQUIPMENT. All necessary testing equipment for calibration and checking of system components shall be provided by System Supplier. System Supplier shall also furnish calibration and maintenance records for all testing and calibration equipment used on the site if requested by Design-Builder.

2-8. PROGRAMMING DEVICES. The following programming devices shall be provided for the instruments specified in other sections:

Instruments Requiring Programming Devices	Quantity of Programming Devices
Panel mounted instruments	1
Flow instruments	1
Pressure and level instruments	1
Analytical instruments	1
Miscellaneous instruments	1

2-9. PROGRAMMING SOFTWARE. The following programming software shall be provided for the instruments specified in other sections where a programming device is not available:

Instruments Requiring Programming Software	Number of Copies of Programming Software
Panel mounted instruments	1
Flow instruments	1
Pressure and level instruments	1
Analytical instruments	1
Miscellaneous instruments	1

PART 3 – EXECUTION

3-1. INSTALLATION REQUIREMENTS. The installation of equipment furnished hereunder for installation at the site shall be by the Design-Builder or their assigned subcontractors.

3-1.01. Field Wiring. Field wiring materials and installation shall be in accordance with the electrical section.

3-1.02. Instrument Installation. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the Drawings.

All outdoor instrumentation shall be protected from direct sun exposure. Instruments shall be placed in locations to limit south and west sun exposure. Sunshades shall be provided on instruments that are subject to the direct sun

exposure. Sunshades shall be located so the opening faces north or east where possible. Sunshades shall be provided as shown on the Drawings.

3-1.03. Salvage of Existing Equipment. Not used.

3-2. SYSTEM SOFTWARE CONFIGURATION. System software shall be configured by the System Supplier. Configuration services shall consist of the creation of the system database, report formats, operator interface graphic and tabular display screen formats, password and security implementation, and programming of control units to provide a fully functioning system. The System Supplier shall fully configure the system using data provided herein or supplied by the Design-Builder and/or the Owner after award of the contract.

The system that is delivered to the field for installation, checkout, and startup shall have all files, or databases, that are configurable in size, sized in a manner in which there will be 50% space available for future work after the completion of this project. This sizing should include the addition of memory modules, disk drives, or any other device to insure the 50% spare space availability. All "tuning" of software that is dependent on space requirements shall be done prior to the completion of this project.

Tuning of software programs shall be accomplished in such a manner that the program operates at its highest performance level. These programs include, but are not limited to Microsoft SQL Server, all PLC ladder logic, and others.

3-2.01. Control System Database. The control system database shall be developed and configured by the System Supplier. The System Supplier shall enter information obtainable from the Contract Documents into the database prior to soliciting input from the Design-Builder and the Owner. The System Supplier shall determine the need for any "pseudo" database points and shall ascertain and enter all information needed to define these points. The System Supplier is responsible for entering all information associated with each point. This includes but is not limited to, descriptions, engineering units, associated displays, areas, security, etc. All fields associated with each database point must be completely filled out accurately.

3-2.02. Graphic Screen Displays. The System Supplier shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored by the control system shall be displayed on one or more graphic screen. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. These items must be done in accordance to the Configuration Standards and Conventions as described later in this section. Alarm and/or event displays shall also be provided and proven functional prior to acceptance of the system. A means of capturing and printing of all graphic screens shall also be included. The software program provided

must be capable of printing the screen in a black and white (using gray scale) or color format. This program must be accessible from all terminals provided under this contract. The black and white printing shall be done in a manner in which the use of the black background is not represented in the printout. This is done to keep the utilization of ink cartridge and toner cartridge to a minimum.

All graphic screens shall be animated to indicate the current state of the piece of equipment. The following graphic screens shall be provided, as a minimum.

- System Overview
- Alarm Summary
- Event Summary
- Overview of each major process area (with vectoring to sub-areas)
- Summary screen to vector to all process trends

A minimum of 300 custom graphic displays shall be provided by the System Supplier.

3-2.03. Report Formats. Report formats shall be developed and programmed by the System Supplier using tag names defined in the database creation. Reports shall be provided as summarized below. All reports will be provided with a header on each page to indicate the contents of each column of information. Each page shall be numbered and indicate the name of the report, the date the report was printed, and the time of the printout. The printout shall also include the time span of the information shown on the report.

- Daily Operating Report. A daily report, listing the major system variables (up to 30 variables) shall be provided. The report shall include hourly values and minimum/maximum/average values where appropriate. A minimum of 6 separate daily reports shall be provided by the System Supplier.
- Monthly Operating Report. A monthly operating report, which averages the values from the above daily reports, shall be provided. The report shall include monthly minimum/maximum/average values where appropriate.

3-2.04. Configuration Standards and Conventions. A “Software Configuration Standards and Conventions” document will be prepared and submitted by the Design-Builder. The document shall be submitted for review and approval before software configuration commences. The document shall describe and define such items as proposed graphic display process line colors/representations; symbology; color standards for “on”, “off”, “opened”, “closed”, and “alarm” conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Before submitting the initial draft document, the System Supplier shall meet with the Design-Builder and/or Owner to review any of the

Owner's existing standards and conventions. All copies of this submittal shall be provided in color to insure the accuracy of each item. No black and white copies

will be accepted. The colors used in the printed submittal shall accurately depict the colors and shapes proposed for use on the final system.

In addition to submitting the document for review, an updated version of the document shall be submitted as part of the O&M Manuals. The document shall be revised to document any additional standards that are established throughout the configuration process.

3-2.05. Configuration Review Meetings. Proposed graphic screens and report formats shall be reviewed with the Owner and Design-Builder throughout the configuration process. The System Supplier's programming personnel shall attend all meetings. A second review meeting shall be held at approximately 50 percent completion. Both meetings shall be held at the Owner's facilities.

3-2.06. Software Functional Requirements. General functional requirements for system configuration are indicated on the Drawings and described in the specifications. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system. The System Supplier shall be responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Design-Builder or the Owner.

3-3. SYSTEMS CHECK. System Supplier shall provide the services of a field manager and a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

3-3.01. Field Manager. System Supplier shall appoint a field services manager who shall be responsible for the coordination of all system check-out and startup activities, and who shall be immediately available to Design-Builder and Owner by phone or on site for the duration of this project.

3-3.02. Field Inspection at Delivery. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

3-3.03. Field Calibration of Instruments. After each instrument has been installed, a technical representative of System Supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final settings. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage

tampering. Instrument calibration shall be done before checkout of the system operation. A typical instrument calibration report is attached to the end of this section.

3-3.04. Training for Installation Personnel. The field supervisor shall train the installation personnel in reading and understanding submittal drawings, and in the correct installation and wiring procedures for the equipment.

3-3.05. Field Inspection Prior to Start Up. After installation and wiring connections are complete, the field supervisor, with additional System Supplier's personnel shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended.

3-3.05.01. Analog Signals. Analog input signals shall be simulated at the transmitting source and verified to be received at the proper register address in the control system. Analog outputs shall be generated at the control system, and verified to be received with the correct polarity, at the respective receiving device.

3-3.05.02. Discrete Signals. Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device, and at the proper voltage.

3-3.05.03. Devices by Other Suppliers. If interrelated devices furnished by other suppliers or under other contracts, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

3-3.05.04. System Check Out Report. The System Supplier shall submit a written report on the results of such tests to Design-Builder. Additional documentation shall be furnished as requested by Design-Builder to establish responsibility for corrective measures. System Supplier shall verify, in writing, to Design-Builder or Owner that System Supplier has successfully completed the external connection check before beginning system startup or field acceptance testing.

3-3.06. Start Up Assistance. After the field supervisor has completed the system check and submitted his report, System Supplier shall supply a factory-trained engineer and programmer to provide on-site start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components. Three (3) working days shall be included for this task.

3-4. TESTING. The system shall be acceptance tested at the factory and on site.

System Supplier shall prepare a testing procedure to be approved by Owner and Design-Builder that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by System Supplier and witnessed by Owner and/or Design-Builder.

System Supplier shall notify Design-Builder and Owner in writing at least 14 days before the proposed testing date. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. System Supplier shall reimburse Owner and Design-Builder for all expenses incurred in connection with attending repeated factory or site testing necessitated by system failure or inadequate preparation.

3-4.01. Factory Acceptance Testing. After system assembly and debugging at System Supplier's facility, the system shall be tested before the system is shipped to the site. The factory test shall be conducted on complete system, including all field I/O devices, communications and network equipment, and peripherals.

The entire system, including all peripherals and associated software, shall be factory tested under simulated operating conditions. Both normal operating sequences and fault conditions shall be simulated. The results shall be noted in the HMI alarm/event log. The testing procedures for hardware and software are described below.

All basic functions shall be demonstrated, including I/O processing, communications, alarm handling, HMI display functions, alarm logging, report generation, and historical data storage, as well as the specific functions listed herein. The system shall operate continuously for at least a 72 hours without faults. This operational test may run concurrently with the demonstration of hardware and software functions. The test procedure shall also include at a least four-hour period for discretionary tests to be conducted by Design-Builder or Owner.

3-4.01.01. Hardware Test. Processors, processor modules, and peripheral devices associated with the system shall be assembled together as they will be installed in the field and shall be tested. The test shall demonstrate proper operation of each hardware device and communications among devices and shall include verification of selected analog and discrete inputs and outputs.

3-4.01.02. Software Test. All system software modules specified herein shall be demonstrated. Software tests shall include running all diagnostics, debugging routines, and system test routines. The operating system, advanced process control language compiler, and all associated drivers shall be fully tested and

operable for the system test. Software "patches" or changes to bypass failed or flawed modules during the test will not be acceptable.

3-4.02. Site Acceptance Testing. After installation and checkout by System Supplier's personnel, the system shall be subjected to an acceptance test.

Site acceptance testing shall be scheduled after receipt of the System Check Out Report and System Supplier shall verify that all field signal changes are reflected in the proper address locations in the system database.

The site acceptance testing shall follow the same procedure as the factory testing and shall operate without loss of basic functions. The number of working days of continuous operation for the test shall be 30. The operational demonstration shall confirm that the status, alarm, and process variable signals are valid and are being updated appropriately, and that the discrete and analog output signals from the control system are being correctly transmitted and implemented. Any errors or abnormal occurrences shall be recorded by System Supplier's field representative. System Supplier's field representative need not be continuously present during the site acceptance testing but shall be available to respond to the site within four hour of notification. The representative shall inspect the system for faults at least once every 24 hours and shall log or record any noted problems. The log shall include a description of the problem, its apparent cause, and any corrective action taken.

3-4.02.01. Failure of Redundant Equipment. Failure of redundant equipment shall not be considered downtime provided that automatic failover occurs as specified and, in the opinion of Design-Builder, the failure was not caused by deficiency in design or installation. In the event of repeated failure of any hardware component or software module, the acceptance test shall be terminated and re-started.

3-4.02.02. Completion of Test. Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the Supplementary Conditions.

3-5. TRAINING. System Supplier shall conduct training courses for personnel selected by Owner. Training shall be provided in the following categories: instrument, control system maintenance, operator (pre-installation), operator (post-installation), programmer (HMI software), programmer (PLC software), networking, and supplemental shall be provided. Training shall be conducted by experienced instructors who are familiar with the specific system supplied.

3-5.01. General Training Requirements. Training requirements shall be in accordance with the Demonstration and Training section.

3-5.01.01. Training Costs. All costs associated with the training program; excluding travel, lodging, and per diem expenses for Owner's and Design-Builder's personnel to attend off-site training programs; shall be the responsibility of System Supplier and shall be included in the contract price.

3-5.02. Instrument Training. Training on the calibration, maintenance, troubleshooting, and repair for the instrument devices provided under this project shall be provided. Training shall also be provided for any hand-held or computer-based calibration devices and their associated software.

3-5.03. Control System Maintenance Training. System maintenance training shall be provided to enable Owner's personnel to perform routine and preventive maintenance, troubleshoot, and repair all hardware furnished with the system, except equipment provided by the HMI computer manufacturer. Maintenance and repair instruction shall assume that Owner's personnel will repair equipment by replacing circuit boards and modules and shall not include instruction on circuit board level repair.

3-5.04. Operator Training. Owner's personnel will utilize the system for day-to-day monitoring and/or control of the facilities. The training program shall provide operators with sufficient knowledge to move from screen to screen within the system, understand the contents of group and detailed point displays, react to and acknowledge alarms, adjust control setpoints and alarm limits, configure and print shift reports, print preconfigured reports on demand, control equipment connected to the system, and react to and resolve minor system errors.

3-5.04.01. Classes. Operator training shall include sessions as specified below.

3-5.04.01.01. Pre-installation Session. Each pre-installation training session shall consist of 8 hours of training for 10 students at the System Supplier's facility 8 hours training for 10 students at the Owner's facility.

3-5.04.01.02. Post-installation Session. The post-installation training shall include three separate, but identical, sessions for three shifts of personnel and shall be conducted at Owner's facilities. Each class shall consist of 8 hours of instruction using the lesson plan submitted and approved for use. The post-installation sessions may have to be conducted outside normal working hours to accommodate the working schedule of Owner's personnel. The post-installation training sessions shall be conducted for 10 of the Owner's operating personnel.

3-5.04.02. Content of Classes. Each session shall cover at least the following topics.

a. Power-up, "bootstrapping", and shutdown of all hardware devices.

b. Logging on and off the system and the use of passwords.

c. Access and interpretation of standard displays and diagnostics.

d. Use and care of operator workstations, servers, video displays, printers, and other control room hardware, including replenishment of supplies and replacement of ribbons and ink cartridges.

e. Moving from screen to screen within the graphic display environment.

f. Interpretation of preconfigured group and detailed point or database displays.

g. Response to and acknowledgment of alarms.

h. Adjustment of control set points and alarm limits.

i. Configuration and printing of shift and other reports by schedule or on demand.

j. Control of field equipment and devices connected to the system.

k. Manual entries to database points.

l. Generation of current (real-time) and historical custom and predefined reports and trend displays.

m. Appropriate responses to software and hardware errors.

n. Enabling and disabling individual inputs and outputs.

The operator-training program shall be developed for personnel with no prior experience with the hardware and software provided as part of the project.

3-5.05. Programmer Training (HMI Software). Programmer training shall be furnished as described in this section.

System programming training shall be provided to enable Owner's and Design-Builder's personnel to initially configure and later reconfigure the system. Programming tasks shall include addition or modification to the system database; modification or creation of graphic and tabular display and report formats; and creation and modification of historical archiving groups and data reduction algorithms.

3-5.05.01. Classes. Programmer training shall be conducted in two sessions. The first session shall consist of 8 hours of instruction for 4 students and shall be conducted at Owner's facilities within 30 days of delivery of the configuration hardware and software. The second session shall consist of 8 hours of instruction for 4 students and shall be conducted at Owner's facility.

3-5.05.02. Content of Classes. Programmer training shall include, but shall not be limited to the following topics:

a. Loading of any supplied software into the system.

b. Use of basic operating system commands for file management, system startup, and creation and editing of batch files.

c. Creation and editing of database.

d. Configuration of printed report formats.

e. Creation and editing of tabular and graphic HMI interface display screens.

f. Diagnostic routines.

g. Creation and modification of control algorithms.

h. Addition of new I/O points and new PLCs to the system.

i. Historical record retrieval, data reduction, archiving, and disk housekeeping.

j. System backup procedures and reloading from backup.

Programmer training shall be designed for personnel who have a general familiarity with control system operation and high-level application programs, but not necessarily with the specific hardware or software furnished for this project.

3-5.05.03. Hardware and Software. The first session of training shall be conducted using hardware and software of the same versions as provided for the system specified. Programmer training for the second session shall be conducted using equipment and software installed at the site.

3-5.06. Programmer Training (PLC Software). Programmer training shall be provided for the PLC software furnished. Programmer training shall be provided on at least the following topics:

a. File management and backup procedures.

b. Documentation printing options.

c. Entering I/O and database points.

d. Logic function programming.

e. PID (Proportional-Integral-Derivative) loop programming and tuning.

f. Error recovery and interpretation of errors.

g. Communication protocol set-up and diagnostics.

PLC software programmer training shall be conducted at the Owner's facilities within 30 days of delivery of PCS.

3-5.06.01. Programmer Training (OIT Software). Programmer training shall be provided for the OIT software furnished. Programmer training shall be provided on at least the following topics:

a. Loading of any supplied software into the system.

b. Use of basic operating system commands for file management and OIT startup.
c. Creation and editing of database.
d. Creation and editing of tabular and graphic OIT display screens.
e. Alarm creation, annunciation, reset and logging.
f. Addition of new I/O points to the system.
g. Diagnostic routines.
h. Communication protocol set-up.
i. System backup procedures and reloading from backup.

3-5.07. Network Training. System Supplier shall provide training on network equipment provided. Network training shall be conducted in one session at Owner's facilities using the hardware and software installed for this project.

a. Course shall provide an overall description of the network and how it operates.
b. A one-hour course (for each make/model of switch, router, and firewall) on configuration shall be provided for up to five people. This instruction shall be aimed at a network administrator's level of understanding and shall be provided by the individual that configured the devices. The course shall review the configuration settings. Course training material shall be vendor provided equipment manuals.
c. A one-hour course on the use of the management software shall be provided for up to five people. This instruction shall be aimed at a network administrator's level of understanding and shall be provided by the individual that configured the software. Course training material shall be vendor provided software manuals.
d. Training shall be provided on the use of any Network Test Equipment provided. Course training material shall be vendor provided equipment manuals.
e. Training on network diagnostics of PLCs, HMIs and Ethernet switches.

The training shall provide instruction for up to 5 Owner-selected students.

3-5.08. Supplemental Training. Not used.

End of Section

INSTRUMENT NAME & SERVICE:		
BRAND & MODEL NO.:		
TAG OR LOOP NO.:		
INPUT/OUTPUT RANGE:		
INPUT	ACTUAL OUTPUT	DESIRED OUTPUT
PROPORTIONAL BAND:		
RESET:		
POSITION OF SWITCHES, JUMPERS, ETC.		
COMMENTS:		
DATE OF CALIBRATION: CALIBRATED BY:		
Black & Veatch	INSTRUMENT CALIBRATION REPORT	Figure 1-40 61 11

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Instrument Device Schedule - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only.
Tag. This is the ISA (or similar) alpha tag representing the function of the instrument.
Service Description. This is the description of the instrument service.
Device Type & Size. This is the instrument device type and should match the description as listed in the specification. Where appropriate, the size of the device (such as diameter of flowmeters) will be listed.
Output Type. This generally will be '4-20 mA' or "Dry Contact'. It could also be a serial output for smart devices (such as HART or FLD-BUS) but only if the serial output is the primary I/O interface.
Output Range. This is the calibrated range for analog devices or the trip point(s) for discrete devices.
Power Type. This will typically be either '2-wire' for loop powered devices or '4-wire' for 24VDC or 120 volt powered devices as indicated on P&ID.
P&ID Drawing. This is the drawing number of the P&ID where the device is shown.
Spec. This column may include a cross reference to another specification section where applicable or to a note which provides additional information. Notes are appended to the end of the device schedule listings.
Provided by a Supplier A "Yes" in this column indicates if the instrument is provided by a Pre-Procured System Supplier (ie. Headworks, MBR, RO, UV). "No" indicates the instrument is provided by the Section 40 61 11 I&C System Supplier.

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
1	21-GRT-PG-1001	TRAIN 1 GRIT PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY GRIT PUMP MFR	N/A	21-I-001	40 73 12	Yes	
2	21-PRW-PSL-1001	TRAIN 1 GRIT PUMP NO. 1 SEAL WATER LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY GRIT PUMP MFR	N/A	21-I-001	40 72 00	Yes	
3	21-SCR-FE-0101	INFLUENT MAIN 1 FLOW	MAGNETIC FLOWMETER	12"	N/A	mV	SEE FIT	N/A	21-I-001	40 71 00	No	
4	21-SCR-FE-0201	INFLUENT MAIN 2 FLOW	MAGNETIC FLOWMETER	8"	N/A	mV	SEE FIT	N/A	21-I-001	40 71 00	No	
5	21-SCR-FIT-0101	INFLUENT MAIN 1 FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-8.20 MGD	4-WIRE	21-I-001	40 71 00	No	
6	21-SCR-FIT-0201	INFLUENT MAIN 2 FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-8.20 MGD	4-WIRE	21-I-001	40 71 00	No	
7	21-SCR-LDIT-1001	COARSE SCREEN NO 1 DIFFERENTIAL LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-10 FT (EL 132.00-142.00)	4-WIRE	21-I-001	40 72 00	Yes	
8	21-SCR-LDSH-1001	COARSE SCREEN NO 1 HIGH DIFFERENTIAL LEVEL	DIFFERENTIAL LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	21-I-001	40 72 00	Yes	
9	21-SCR-LE-1001A	COARSE SCREEN NO 1 UPSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	21-I-001	40 72 00	Yes	
10	21-SCR-LE-1001B	COARSE SCREEN NO 1 DOWNSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	21-I-001	40 72 00	Yes	
11	21-SCR-LSHH-1001	COARSE SCREEN NO 1 HIGH-HIGH UPSTREAM LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ EL 141.33 INCREASING	N/A	21-I-001	40 72 00	Yes	
12	21-SCR-OSH-1001	COARSE SCREEN NO 1 HIGH TORQUE	TORQUE SWITCH	N/A	N/A	DRY CONTACT	BY SCREEN MFR	N/A	21-I-001	46 21 12	Yes	
13	21-SCR-PSL-1001	TRAIN 1 WASHER COMPACTOR PLANT WATER SYSTEM HEADER LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI DECREASING	N/A	21-I-001	40 72 00	Yes	
14	21-GRT-PG-2001	TRAIN 2 GRIT PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY GRIT PUMP MFR	N/A	21-I-002	40 73 12	Yes	
15	21-PRW-PSL-2001	TRAIN 1 GRIT PUMP NO. 2 SEAL WATER LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY GRIT PUMP MFR	N/A	21-I-002	40 72 00	Yes	
16	21-SCR-LDIT-2001	COARSE SCREEN NO 2 DIFFERENTIAL LEVEL	DIFFERENTIAL LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-10 FT (EL 132.00-142.00)	4-WIRE	21-I-002	40 72 00	Yes	
17	21-SCR-LDSH-2001	COARSE SCREEN NO 2 DIFFERENTIAL LEVEL SWITCH	DIFFERENTIAL LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	21-I-002	40 72 00	Yes	
18	21-SCR-LE-2001A	COARSE SCREEN NO 2 UPSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	21-I-002	40 72 00	Yes	
19	21-SCR-LE-2001B	COARSE SCREEN NO 2 DOWNSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	21-I-002	40 72 00	Yes	
20	21-SCR-LSHH-2001	COARSE SCREEN NO 2 HIGH-HIGH UPSTREAM LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ EL 141.33 INCREASING	N/A	21-I-002	40 72 00	Yes	
21	21-SCR-OSH-2001	COARSE SCREEN NO 2 HIGH TORQUE	TORQUE SWITCH	N/A	N/A	DRY CONTACT	BY SCREEN MFR	N/A	21-I-002	46 21 12	Yes	
22	21-SCR-PSL-2001	TRAIN 2 WASHER COMPACTOR PLANT WATER SYSTEM HEADER LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI DECREASING	N/A	21-I-002	40 72 00	Yes	
23	22-PRW-PSL-1001	FINE SCREEN 1 PLANT WATER SYSTEM HEADER LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI DECREASING	N/A	22-I-001	40 72 00	Yes	
24	22-PRW-PSL-2001	FINE SCREEN 2 PLANT WATER SYSTEM HEADER LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI DECREASING	N/A	22-I-001	40 72 00	Yes	
25	22-SCR-FE-1001	FINE SCREEN 1 INLET HEADER FLOW	MAGNETIC FLOWMETER	8"	N/A	mV	SEE FIT	N/A	22-I-001	40 71 00	No	
26	22-SCR-FE-2001	FINE SCREEN 2 INLET HEADER FLOW	MAGNETIC FLOWMETER	8"	N/A	mV	SEE FIT	N/A	22-I-001	40 71 00	No	
27	22-SCR-FIT-1001	FINE SCREEN 1 INLET HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-2.00 MGD	4-WIRE	22-I-001	40 71 00	No	
28	22-SCR-FIT-2001	FINE SCREEN 2 INLET HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-2.00 MGD	4-WIRE	22-I-001	40 71 00	No	
29	22-SCR-LDIT-1001	FINE SCREEN NO 1 DIFFERENTIAL LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-5 FT (EL 127.00-132.00)	4-WIRE	22-I-001	40 72 00	Yes	
30	22-SCR-LDIT-2001	FINE SCREEN NO 2 DIFFERENTIAL LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-5 FT (EL 127.00-132.00)	4-WIRE	22-I-001	40 72 00	Yes	
31	22-SCR-LE-0001	SAFE DIVERSION BOX LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	22-I-001	40 72 00	No	
32	22-SCR-LE-1001A	FINE SCREEN NO 1 UPSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	22-I-001	40 72 00	Yes	
33	22-SCR-LE-1001B	FINE SCREEN NO 1 DOWNSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	22-I-001	40 72 00	Yes	
34	22-SCR-LE-2001A	FINE SCREEN NO 2 UPSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	22-I-001	40 72 00	Yes	
35	22-SCR-LE-2001B	FINE SCREEN NO 2 DOWNSTREAM LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	22-I-001	40 72 00	Yes	
36	22-SCR-LIT-0001	SAFE DIVERSION BOX LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-9 FT (EL 127.00-136.00)	4-WIRE	22-I-001	40 72 00	No	
37	22-SCR-SSL-0001	SCREENED CONVEYOR ZERO SPEED	ZERO SPEED SWITCH	N/A	N/A	DRY CONTACT	BY CONVEYOR MFR	N/A	22-I-001	40 72 00	Yes	
38	23-ODC-AE-0001	RECIRCULATION PUMP DISCHARGE pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	23-I-001	40 75 00	Yes	
39	23-ODC-AIT-0001	RECIRCULATION PUMP DISCHARGE pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	23-I-001	40 75 00	Yes	
40	23-ODC-FE-1001	RECYCLED WATER FLOW TO ODOR CONTROL SYSTEM	PROPELLER FLOWMETER	2"	N/A	N/A	SEE FIT	N/A	23-I-001	40 71 00	Yes	
41	23-ODC-FG-1001	RECYCLED WATER FLOW TO ODOR CONTROL SYSTEM	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
42	23-ODC-FG-1002	RECIRCULATION FLOW TO STAGE 1 HUMIDIFIER	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
43	23-ODC-FIT-1001	RECYCLED WATER FLOW TO ODOR CONTROL SYSTEM	PROPELLER FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY ODOR CONTROL MFR	4-WIRE	23-I-001	43 11 21	Yes	
44	23-ODC-FSL-0001	RECIRCULATION PUMP DISCHARGE LOW FLOW	TARGET-TYPE FLOW SWITCH	N/A	N/A	DRY CONTACT	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
45	23-ODC-FSL-0001	ODOR CONTROL FAN DISCHARGE LOW FLOW	TARGET-TYPE FLOW SWITCH	N/A	N/A	DRY CONTACT	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
46	23-ODC-FSL-1001	RECYCLED WATER LOW FLOW TO ODOR CONTROL SYSTEM	TARGET-TYPE FLOW SWITCH	N/A	N/A	DRY CONTACT	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
47	23-ODC-LSL-0002	ODOR CONTROL STAGE 1 HUMIDIFIER LOW LEVEL	FIXED-MOUNTED FLOAT TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
48	23-ODC-PDG-0001	ODOR CONTROL STAGE 1 HUMIDIFIER DIFFERENTIAL PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
49	23-ODC-PDG-0002	ODOR CONTROL STAGE 2 BIOFILTER DIFFERENTIAL PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
50	23-ODC-PDIT-0001	ODOR CONTROL PRE-FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY ODOR CONTROL MFR	2-WIRE	23-I-001	43 11 21	Yes	
51	23-ODC-PDSL-0001	ODOR CONTROL FAN LOW DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI DECREASING	N/A	23-I-001	40 72 00	Yes	
52	23-ODC-PG-0001	RECIRCULATION PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
53	23-ODC-PG-0002	RECIRCULATION PUMP SUCTION PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
54	23-ODC-PG-1001	RECYCLED WATER PRESSURE TO ODOR CONTROL SYSTEM	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
55	23-ODC-PG-1002	ODOR CONTROL STAGE 2 BIOFILTER RECIRC PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY ODOR CONTROL MFR	N/A	23-I-001	43 11 21	Yes	
56	23-ODC-TG-0001	OCS STAGE 1 HUMIDIFIER TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	N/A	0-200 F	N/A	23-I-001	40 74 00	Yes	
57	23-ODC-TG-0002	OCS STAGE 2 BIOFILTER TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	N/A	0-200 F	N/A	23-I-001	40 74 00	Yes	
58	23-ODC-VSH-0001	ODOR CONTROL FAN HIGH VIBRATION	VIBRATION SWTICH	N/A	N/A	DRY CONTACT	BY FAN MFR	N/A	23-I-001	43 11 21	Yes	
59	31-AER-FE-1101	BLOWERS TO AERATION BASIN 1 DIFFUSERS AIR FLOW	THERMAL DISPERSION FLOWMETER	8"	N/A	mV	SEE FIT	N/A	31-I-001	40 71 00	Yes	
60	31-AER-FE-1201	BLOWERS TO AERATION BASIN 1 DIFFUSERS AIR FLOW	THERMAL DISPERSION FLOWMETER	6"	N/A	mV	SEE FIT	N/A	31-I-001	40 71 00	Yes	
61	31-AER-FIT-1101	AERATION BASIN 1 ZONE 1 AIR FLOW	THERMAL DISPERSION FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY BLOWER MFR	4-WIRE	31-I-001	40 71 00	Yes	
62	31-AER-FIT-1201	AERATION BASIN 1 ZONE 2 AIR FLOW	THERMAL DISPERSION FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY BLOWER MFR	4-WIRE	31-I-001	40 71 00	Yes	
63	31-BNR-AE-0001	BNR SPLITTER BOX pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-001	40 75 00	No	
64	31-BNR-AE-1001	BASIN 1 ANOXIC AREA OXYGEN REDUCTION POTENTIAL	ORP SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-001	40 75 00	No	
65	31-BNR-AE-1002	AERATION BASIN 1 MIXED LIQUOR SUSPENDED SOLIDS	SUSPENDED SOLIDS SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-001	40 75 00	No	
66	31-BNR-AE-1003	AERATION BASIN 1 AMMONIA/AMMONIUM	AMMONIA/AMMONIUM NH3/NH4) SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-001	40 75 00	No	
67	31-BNR-AE-1101	AERATION BASIN 1 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-001	40 75 00	Yes	
68	31-BNR-AE-1201	AERATION BASIN 1 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-001	40 75 00	Yes	
69	31-BNR-AIT-0001	BNR SPLITTER BOX pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	31-I-001	40 75 00	No	
70	31-BNR-AIT-1001	BASIN 1 ANOXIC AREA OXYGEN REDUCTION POTENTIAL	ORP ANALYZER	N/A	N/A	4-20mA	-1,500-1,500 mV	4-WIRE	31-I-001	40 75 00	No	
71	31-BNR-AIT-1002	AERATION BASIN 1 MIXED LIQUOR SUSPENDED SOLIDS	SUSPENDED SOLIDS ANALZER	N/A	N/A	4-20mA	0.1-9,999 NTU	4-WIRE	31-I-001	40 75 00	No	
72	31-BNR-AIT-1003	AERATION BASIN 1 AMMONIA/AMMONIUM CONTENT	AMMONIA/AMMONIUM (NH3/NH4) ANALYZER	N/A	N/A	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	31-I-001	40 75 00	No	
73	31-BNR-AIT-1101	AERATION BASIN 1 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN ANALYZER	N/A	N/A	4-20mA	0-20 mg/L	4-WIRE	31-I-001	40 75 00	Yes	
74	31-BNR-AIT-1201	AERATION BASIN 1 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN ANALYZER	N/A	N/A	4-20mA	0-20 mg/L	4-WIRE	31-I-001	40 75 00	Yes	
75	31-MEM-LE-1001	BASIN 1 MIXED LIQUOR COLLECTION CHANNEL LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	31-I-001	40 72 00	No	
76	31-MEM-LIT-1001	BASIN 1 MIXED LIQUOR COLLECTION CHANNEL LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-12.0 FT	4-WIRE	31-I-001	40 72 00	No	
77	31-RAS-AE-0001	RAS DEOX AREA TOTAL SUSPENDED SOLIDS	SUSPENDED SOLIDS SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-001	40 75 00	No	
78	31-RAS-AIT-0001	RAS DEOX AREA TOTAL SUSPENDED SOLIDS	SUSPENDED SOLIDS ANALZER	N/A	N/A	4-20mA	0.1-9,999 NTU	4-WIRE	31-I-001	40 75 00	No	
79	31-AER-FE-2101	BLOWERS TO AERATION BASIN 2 DIFFUSERS AIR FLOW	THERMAL DISPERSION FLOWMETER	8"	N/A	mV	SEE FIT	N/A	31-I-002	40 71 00	Yes	
80	31-AER-FE-2201	BLOWERS TO AERATION BASIN 2 DIFFUSERS AIR FLOW	THERMAL DISPERSION FLOWMETER	6"	N/A	mV	SEE FIT	N/A	31-I-002	40 71 00	Yes	
81	31-AER-FIT-2101	AERATION BASIN 2 ZONE 1 AIR FLOW	THERMAL DISPERSION FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY BLOWER MFR	4-WIRE	31-I-002	40 71 00	Yes	
82	31-AER-FIT-2201	AERATION BASIN 2 ZONE 2 AIR FLOW	THERMAL DISPERSION FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY BLOWER MFR	4-WIRE	31-I-002	40 71 00	Yes	
83	31-BNR-AE-2001	BASIN 2 ANOXIC AREA OXYGEN REDUCTION POTENTIAL	ORP SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-002	40 75 00	No	
84	31-BNR-AE-2002	AERATION BASIN 2 MIXED LIQUOR SUSPENDED SOLIDS	SUSPENDED SOLIDS SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-002	40 75 00	No	
85	31-BNR-AE-2003	AERATION BASIN 2 AMMONIA/AMMONIUM	AMMONIA/AMMONIUM NH3/NH4) SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-002	40 75 00	No	
86	31-BNR-AE-2101	AERATION BASIN 2 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-002	40 75 00	Yes	
87	31-BNR-AE-2201	AERATION BASIN 2 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN SENSOR	N/A	N/A	mV	SEE AIT	N/A	31-I-002	40 75 00	Yes	
88	31-BNR-AIT-2001	BASIN 2 ANOXIC AREA OXYGEN REDUCTION POTENTIAL	ORP ANALYZER	N/A	N/A	4-20mA	-1,500-1,500 mV	4-WIRE	31-I-002	40 75 00	No	
89	31-BNR-AIT-2002	AERATION BASIN 2 MIXED LIQUOR SUSPENDED SOLIDS	SUSPENDED SOLIDS ANALZER	N/A	N/A	4-20mA	0.1-9,999 NTU	4-WIRE	31-I-002	40 75 00	No	
90	31-BNR-AIT-2003	AERATION BASIN 2 AMMONIA/AMMONIUM	AMMONIA/AMMONIUM (NH3/NH4) ANALYZER	N/A	N/A	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	31-I-002	40 75 00	No	
91	31-BNR-AIT-2101	AERATION BASIN 2 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN ANALYZER	N/A	N/A	4-20mA	0-20 mg/L	4-WIRE	31-I-002	40 75 00	Yes	
92	31-BNR-AIT-2201	AERATION BASIN 2 AEROBIC ZONE DISSOLVED OXYGEN	DISSOLVED OXYGEN ANALYZER	N/A	N/A	4-20mA	0-20 mg/L	4-WIRE	31-I-002	40 75 00	Yes	
93	31-MEM-LE-2001	BASIN 2 MIXED LIQUOR COLLECTION CHANNEL LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	31-I-002	40 72 00	No	
94	31-MEM-LIT-2001	BASIN 2 MIXED LIQUOR COLLECTION CHANNEL LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-12.0 FT	4-WIRE	31-I-002	40 72 00	No	
95	31-SCM-PG-0002	SCUM PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	31-I-003	40 73 12	No	
96	31-SCM-PSH-0002	SCUM PUMP DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 36 PSI INCREASING	N/A	31-I-003	40 72 00	No	
97	31-SCM-PSL-0001	SCUM PUMP SUCTION LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 5" Hg VAC DECREASING	N/A	31-I-003	40 72 00	No	
98	31-WAS-FE-0001	MBR RAS TO SCUM/WAS PUMPS HEADER FLOW	MAGNETIC FLOWMETER	2"	N/A	mV	SEE FIT	N/A	31-I-003	40 71 00	No	
99	31-WAS-FE-0002	SCUM/WAS PUMPS OUTLET HEADER FLOW	MAGNETIC FLOWMETER	2"	N/A	mV	SEE FIT	N/A	31-I-003	40 71 00	No	
100	31-WAS-FIT-0001	MBR RAS TO SCUM/WAS PUMPS HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-100 GPM	4-WIRE	31-I-003	40 71 00	No	
101	31-WAS-FIT-0002	SCUM/WAS PUMPS OUTLET HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-80 GPM	4-WIRE	31-I-003	40 71 00	No	
102	31-WAS-LIT-0001	SCUM/WAS WETWELL LEVEL	FLANGE-MOUNTED PRESSURE SENSING LEVEL TRANSMITTER	N/A	3"	4-20mA	0-9.00 FT (EL 120.5-129.50)	2-WIRE	31-I-003	40 72 00	No	
103	31-WAS-LSHH-0001	SCUM/WAS WETWELL HIGH-HIGH LEVEL	PRESSURE SENSING LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 8.50 FT INCREASING	N/A	31-I-003	40 72 00	No	
104	31-WAS-LSLL-0001	SCUM/WAS WETWELL LOW-LOW LEVEL	PRESSURE SENSING LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 3.0 FT DECREASING	N/A	31-I-003	40 72 00	No	
105	31-WAS-PG-0002	WAS PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	31-I-003	40 73 12	No	
106	31-WAS-PSH-0002	WAS PUMP DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 36 PSI INCREASING	N/A	31-I-003	40 72 00	No	
107	31-WAS-PSL-0001	WAS PUMP SUCTION PRESSURE LOW	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 5" Hg VAC DECREASING	N/A	31-I-003	40 72 00	No	
108	31-AER-PDG-0101	PROCESS AIR BLOWER NO. 1 INLET DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	BY BLOWER MFR	N/A	31-I-004	40 72 00	Yes	
109	31-AER-PDG-0201	PROCESS AIR BLOWER NO. 2 INLET DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	BY BLOWER MFR	N/A	31-I-004	40 72 00	Yes	
110	31-AER-PDG-0301	PROCESS AIR BLOWER NO. 2 INLET DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	BY BLOWER MFR	N/A	31-I-004	40 72 00	Yes	
111	31-AER-PDSH-0101	PROCESS AIR BLOWER NO. 1 INLET HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	31-I-004	40 72 00	Yes	
112	31-AER-PDSH-0201	PROCESS AIR BLOWER NO. 2 INLET HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	31-I-004	40 72 00	Yes	
113	31-AER-PDSH-0301	PROCESS AIR BLOWER NO. 3 INLET HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	31-I-004	40 72 00	Yes	
114	31-AER-PG-0101	PROCESS AIR BLOWER NO. 1 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-15 PSIG	N/A	31-I-004	40 73 12	Yes	
115	31-AER-PG-0201	PROCESS AIR BLOWER NO. 2 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-15 PSIG	N/A	31-I-004	40 73 12	Yes	
116	31-AER-PG-0302	PROCESS AIR BLOWER NO. 3 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-15 PSIG	N/A	31-I-004	40 73 12	Yes	
117	31-AER-PIT-0001	PROCESS AIR BLOWERS COMMON HEADER LINE PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-20 PSI	2-WIRE	31-I-004	40 72 00	No	

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
118	31-AER-PSH-0101	DRY SCREW PROCESS AIR BLOWER NO. 1 OUTLET HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	31-I-004	40 72 00	Yes	
119	31-AER-PSH-0201	DRY SCREW PROCESS AIR BLOWER NO. 2 OUTLET HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	31-I-004	40 72 00	Yes	
120	31-AER-PSH-0302	DRY SCREW PROCESS AIR BLOWER NO. 3 OUTLET HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	31-I-004	40 72 00	Yes	
121	31-AER-TG-0101	DRY SCREW PROCESS AIR BLOWER NO. 1 OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	4-1/2"	N/A	0-200 F	N/A	31-I-004	40 74 00	Yes	
122	31-AER-TG-0201	DRY SCREW PROCESS AIR BLOWER NO. 2 OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	4-1/2"	N/A	0-200 F	N/A	31-I-004	40 74 00	Yes	
123	31-AER-TG-0301	DRY SCREW PROCESS AIR BLOWER NO. 3 OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	4-1/2"	N/A	0-200 F	N/A	31-I-004	40 74 00	Yes	
124	32-MEM-FE-1001	RAS COLLECTION CHANNEL NO. 1 TO RAS DEOX FLOW	MAGNETIC FLOWMETER	14"	N/A	mV	SEE FIT	N/A	32-I-001	40 71 00	No	
125	32-MEM-FIT-1001	RAS COLLECTION CHANNEL NO. 1 TO RAS DEOX FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-1,200 GPM	4-WIRE	32-I-001	40 71 00	No	
126	32-MEM-LE-1001	MEMBRANE BASIN 1 LEVEL	CONDUCTANCE TYPE LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	32-I-001	40 72 00	Yes	
127	32-MEM-LE-1002	RAS COLLECTION CHANNEL NO. 1 LEVEL	RADAR LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	32-I-001	40 72 00	No	
128	32-MEM-LIT-1001	MEMBRANE BASIN 1 LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-12 FT	4-WIRE	32-I-001	40 72 00	Yes	
129	32-MEM-LIT-1002	RAS COLLECTION CHANNEL NO. 1 LEVEL	RADAR LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-8.5 FT (EL 120.50-129.00	2-WIRE	32-I-001	40 72 00	No	
130	32-MEM-LSHH-1001	MEMBRANE BASIN 1 HIGH-HIGH LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY MBR MFR	N/A	32-I-001	40 72 00	Yes	
131	32-MEM-LSLL-1001	MEMBRANE BASIN 1 LOW-LOW LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY MBR MFR	N/A	32-I-001	40 72 00	Yes	
132	32-MEM-PIT-1001	MEMBRANE BASIN 1 FILTRATE PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	-15-15 PSIG	2-WIRE	32-I-001	40 72 00	Yes	
133	32-MEM-FE-2001	RAS COLLECTION CHANNEL NO. 2 TO RAS DEOX FLOW	MAGNETIC FLOWMETER	14"	N/A	mV	SEE FIT	N/A	32-I-002	40 71 00	No	
134	32-MEM-FIT-2001	FILTRATE PUMP NO. 2 DISCHARGE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-950 GPM	4-WIRE	32-I-002	40 71 00	No	
135	32-MEM-LE-2001	MEMBRANE BASIN 2 LEVEL	CONDUCTANCE TYPE LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	32-I-002	40 72 00	Yes	
136	32-MEM-LE-2002	RAS COLLECTION CHANNEL NO. 2 LEVEL	RADAR LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	32-I-002	40 72 00	No	
137	32-MEM-LIT-2001	MEMBRANE BASIN 2 LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-12 FT	4-WIRE	32-I-002	40 72 00	Yes	
138	32-MEM-LIT-2002	RAS COLLECTION CHANNEL NO. 2 LEVEL	RADAR LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-8.5 FT (EL 120.50-129.00	2-WIRE	32-I-002	40 72 00	No	
139	32-MEM-LSHH-2001	MEMBRANE BASIN 2 HIGH-HIGH LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY MBR MFR	N/A	32-I-002	40 72 00	Yes	
140	32-MEM-LSLL-2001	MEMBRANE BASIN 2 LOW-LOW LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY MBR MFR	N/A	32-I-002	40 72 00	Yes	
141	32-MEM-PIT-2001	MEMBRANE BASIN 2 FILTRATE PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	-15-15 PSIG	2-WIRE	32-I-002	40 72 00	Yes	
142	32-MEM-AE-1001	FILTRATE PUMP NO. 1 DISCHARGE TURBIDITY	LOW RANGE TURBIDITY SENSOR	N/A	N/A	mV	SEE AIT	N/A	32-I-003	40 75 00	Yes	
143	32-MEM-AIT-1001	FILTRATE PUMP NO. 1 DISCHARGE TURBIDITY	LOW RANGE TURBIDITY ANALYZER	N/A	N/A	4-20mA	0-10 NTU	4-WIRE	32-I-003	40 75 00	Yes	
144	32-MEM-FE-1001	FILTRATE PUMP NO. 1 DISCHARGE FLOW	MAGNETIC FLOWMETER	8"	N/A	mV	SEE FIT	N/A	32-I-003	40 71 00	Yes	
145	32-MEM-FG-1001	TURBIDITY ANALYZER SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	0-1,000 mL/min	N/A	32-I-003	40 71 00	Yes	
146	32-MEM-FIT-1001	FILTRATE PUMP NO. 1 DISCHARGE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-950 GPM	4-WIRE	32-I-003	40 71 00	Yes	
147	32-MEM-PG-1002	FILTRATE PUMP NO. 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-30 PSI	N/A	32-I-003	40 73 12	Yes	
148	32-MEM-PSH-1002	FILTRATE PUMP NO. 1 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 40 PSI INCREASING	N/A	32-I-003	40 72 00	Yes	
149	32-MEM-AE-2001	FILTRATE PUMP NO. 2 DISCHARGE TURBIDITY	LOW RANGE TURBIDITY SENSOR	N/A	N/A	mV	SEE AIT	N/A	32-I-004	40 75 00	Yes	
150	32-MEM-AIT-2001	FILTRATE PUMP NO. 2 DISCHARGE TURBIDITY	LOW RANGE TURBIDITY ANALYZER	N/A	N/A	4-20mA	0-10 NTU	4-WIRE	32-I-004	40 75 00	Yes	
151	32-MEM-FE-2001	FILTRATE PUMP NO. 2 DISCHARGE FLOW	MAGNETIC FLOWMETER	8"	N/A	mV	SEE FIT	N/A	32-I-004	40 71 00	Yes	
152	32-MEM-FG-2001	TURBIDITY ANALYZER SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	0-1,000 mL/min	N/A	32-I-004	40 71 00	Yes	
153	32-MEM-FIT-2001	FILTRATE PUMP NO. 2 DISCHARGE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-1,200 GPM	4-WIRE	32-I-004	40 71 00	Yes	
154	32-MEM-PG-2002	FILTRATE PUMP NO. 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-30 PSI	N/A	32-I-004	40 73 12	Yes	
155	32-MEM-PSH-2002	FILTRATE PUMP NO. 2 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 40 PSI INCREASING	N/A	32-I-004	40 72 00	Yes	
156	32-MEM-AE-0002	RO FEED TANK INLET HEADER TURBIDITY	LOW RANGE TURBIDITY SENSOR	N/A	N/A	mV	SEE AIT	N/A	32-I-005	40 75 00	Yes	
157	32-MEM-AIT-0002	RO FEED TANK INLET HEADER TURBIDITY	LOW RANGE TURBIDITY ANALYZER	N/A	N/A	4-20mA	0-10 ntu	4-WIRE	32-I-005	40 75 00	Yes	
158	32-MEM-FG-0002	TURBIDITY ANALYZER SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	0-1,000 mL/min	N/A	32-I-005	40 71 00	Yes	
159	32-MEM-TIT-0001	RO FEED TANK INLET HEADER TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	N/A	4-20mA	32-120 F	2-WIRE	32-I-005	40 74 00	Yes	
160	32-AIR-FSL-0101	ROTARY LOBE MEMBRANE SCOUR BLOWER NO. 1 OUTLET LOW FLOW	TARGET TYPE FLOW SWITCH	N/A	N/A	DRY CONTACT	0-66 FT/SEC TRIP @ XX FT/SEC DECREASING	N/A	32-I-006	40 71 00	Yes	XX TO BE DETERMINED BY FLOW MFR.
161	32-AIR-FSL-0201	ROTARY LOBE MEMBRANE SCOUR BLOWER NO. 2 OUTLET LOW FLOW	TARGET TYPE FLOW SWITCH	N/A	N/A	DRY CONTACT	0-66 FT/SEC TRIP @ XX FT/SEC DECREASING	N/A	32-I-006	40 71 00	Yes	XX TO BE DETERMINED BY FLOW MFR.
162	32-AIR-PDG-0101	MEMBRANE AIR SCOUR BLOWER NO. 1 INLET DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	BY BLOWER MFR	N/A	32-I-006	40 72 00	Yes	
163	32-AIR-PDG-0201	MEMBRANE AIR SCOUR BLOWER NO. 2 INLET DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	BY BLOWER MFR	N/A	32-I-006	40 72 00	Yes	
164	32-AIR-PDSH-0101	MEMBRANE AIR SCOUR BLOWER NO. 1 INLET HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	32-I-006	40 72 00	Yes	
165	32-AIR-PDSH-0201	MEMBRANE AIR SCOUR BLOWER NO. 2 INLET HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	32-I-006	40 72 00	Yes	
166	32-AIR-PG-0102	MEMBRANE AIR SCOUR BLOWER NO. 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY BLOWER MFR	N/A	32-I-006	40 73 12	Yes	
167	32-AIR-PG-0202	MEMBRANE AIR SCOUR BLOWER NO. 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY BLOWER MFR	N/A	32-I-006	40 73 12	Yes	
168	32-AIR-PSH-0102	MEMBRANE AIR SCOUR BLOWER NO. 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	32-I-006	40 72 00	Yes	
169	32-AIR-PSH-0202	MEMBRANE AIR SCOUR BLOWER NO. 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	32-I-006	40 72 00	Yes	
170	32-DRN-FE-0001	DRAIN PUMP OUTLET FLOW	MAGNETIC FLOWMETER	6"	N/A	mV	SEE FIT	N/A	32-I-007	40 71 00	Yes	
171	32-DRN-FIT-0001	DRAIN PUMP OUTLET FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-750 GPM	4-WIRE	32-I-007	40 71 00	Yes	
172	32-DRN-PG-0001	DRAIN PUMP SUCTION PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY PUMP MFR	N/A	32-I-007	40 73 12	Yes	
173	32-DRN-PG-0002	DRAIN PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY PUMP MFR	N/A	32-I-007	40 73 12	Yes	
174	32-DRN-PSH-0002	DRAIN PUMP DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY PUMP MFR	N/A	32-I-007	40 72 00	Yes	
175	32-AIR-PDG-1001	COMPRESSOR AIR TANK DISCHARGE FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	4-1/2"	N/A	BY MBR MFR	N/A	32-I-008	40 72 00	Yes	
176	32-AIR-PI-1001	COMPRESSOR AIR TANK PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-300 PSI	N/A	32-I-008	40 78 00	Yes	
177	32-AIR-PSL-1001	COMPRESSOR AIR TANK LOW-LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 110 PSIG DECREASING	N/A	32-I-008	40 72 00	Yes	
178	32-AIR-PSL-1002	COMPRESSOR AIR TANK DISCHARGE LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 90 PSIG DECREASING	N/A	32-I-008	40 72 00	Yes	
179	32-AIR-PSLL-1003	COMPRESSOR AIR TANK DISCHARGE LOW-LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 70 PSIG DECREASING	N/A	32-I-008	40 72 00	Yes	
180	33-MEM-FG-0001	NH3 ANALYSER SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY MBR MFR	N/A	33-I-001	40 71 00	Yes	
181	33-RO-AE-0001	RO FEED TANK INLET HEADER AMMONIA	AMMONIA (NH3) SENSOR	N/A	N/A	mV	SEE AIT	N/A	33-I-001	40 75 00	Yes	
182	33-RO-AIT-0001	RO FEED TANK INLET HEADER AMMONIA	AMMONIA (NH3) ANAYLZER	N/A	N/A	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	33-I-001	40 75 00	Yes	
183	33-RO-LIT-0101	RO FEED TANK 1 LEVEL	FLANGE-MOUNTED PRESSURE SENSING LEVEL TRANSMITTER	N/A	3"	4-20mA	0-21.00 FT (EL 120.5-141.50)	2-WIRE	33-I-001	40 72 00	No	
184	33-RO-LIT-0201	RO FEED TANK 2 LEVEL	FLANGE-MOUNTED PRESSURE SENSING LEVEL TRANSMITTER	N/A	3"	4-20mA	0-21.00 FT (EL 120.5-141.50)	2-WIRE	33-I-001	40 72 00	No	

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
185	33-RO-LSHH-0101	RO FEED TANK 1 HIGH-HIGH LEVEL	PRESSURE SENSING LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 20.6 FT INCREASING	N/A	33-I-001	40 72 00	No	
186	33-RO-LSHH-0201	RO FEED TANK 2 HIGH-HIGH LEVEL	PRESSURE SENSING LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 20.6 FT INCREASING	N/A	33-I-001	40 72 00	No	
187	33-RO-LSLL-0101	RO FEED TANK 1 LOW-LOW LEVEL	PRESSURE SENSING LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 2.9 FT DECREASING	N/A	33-I-001	40 72 00	No	
188	33-RO-LSLL-0201	RO FEED TANK 2 LOW-LOW LEVEL	PRESSURE SENSING LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 2.9 FT DECREASING	N/A	33-I-001	40 72 00	No	
189	34-PRW-FE-0001	RECYCLED WATER PUMP COMMON OUTLET HEADER FLOW	MAGNETIC FLOWMETER	3"	N/A	mV	SEE FIT	N/A	34-I-001	40 71 00	No	
190	34-PRW-FIT-0001	RECYCLED WATER PUMP COMMON OUTLET HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-150 GPM	4-WIRE	34-I-001	40 71 00	No	
191	34-PRW-PG-0001	AIR BLADDER STORAGE TANK PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	34-I-001	40 73 12	No	
192	34-PRW-PG-0102	RECYCLED WATER PUMP NO. 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	34-I-001	40 73 12	No	
193	34-PRW-PG-0202	RECYCLED WATER PUMP NO. 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	34-I-001	40 73 12	No	
194	34-PRW-PG-0302	RECYCLED WATER PUMP NO. 3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	34-I-001	40 73 12	No	
195	34-PRW-PIT-0001	RECYCLED WATER PUMP DISCHARGE HEADER PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-1/2"	4-20mA	0-100 PSI	2-WIRE	34-I-001	40 72 00	No	
196	34-PRW-PSH-0102	RECYCLED WATER PUMP NO. 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	34-I-001	40 72 00	No	
197	34-PRW-PSH-0202	RECYCLED WATER PUMP NO. 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	34-I-001	40 72 00	No	
198	34-PRW-PSH-0302	RECYCLED WATER PUMP NO. 3 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	34-I-001	40 72 00	No	
199	51-RO-AE-0001	RO FEED HEADER CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-001	40 75 00	No	
200	51-RO-AE-0002	RO FEED HEADER TURBIDITY	TURBIDITY SENSOR	N/A	N/A	mV	SEE AIT	N/A	51-I-001	40 75 00	No	
201	51-RO-AE-0003	RO FEED HEADER OXYGEN REDUCTION POTENTIAL	ORP SENSOR	N/A	N/A	mV	SEE AIT	N/A	51-I-001	40 75 00	No	
202	51-RO-AE-0004	RO FEED HEADER FREE CHLORINE	CHLORINE RESIDUAL SENSOR	N/A	N/A	mV	SEE AIT	N/A	51-I-001	40 75 00	No	
203	51-RO-AE-0005	RO FEED HEADER MONO-CHLORIMINE / AMMONIA	MONO-CHLORIMINE/AMMONIA SENSOR	N/A	N/A	mV	SEE AIT	N/A	51-I-001	40 75 00	No	
204	51-RO-AE-0006	RO FEED HEADER INLET pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	51-I-001	40 75 00	No	
205	51-RO-AIT-0001	RO FEED HEADER CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-001	40 75 00	No	
206	51-RO-AIT-0002	RO FEED HEADER TURBIDITY	TURBIDITY ANALYZER	N/A	N/A	4-20mA	0-40 NTU	4-WIRE	51-I-001	40 75 00	No	
207	51-RO-AIT-0003	RO FEED HEADER ORP	ORP ANALYZER	N/A	N/A	4-20mA	-1,500-1,500 mV	4-WIRE	51-I-001	40 75 00	No	
208	51-RO-AIT-0004	RO FEED HEADER FREE CHLORINE	CHLORINE RESIDUAL ANALYZER	N/A	N/A	4-20mA	0-10 mg/L	4-WIRE	51-I-001	40 75 00	No	
209	51-RO-AIT-0005	RO FEED HEADER MONO-CHLORIMINE / AMMONIA	MONOCHLORIMINE/ AMMONIA ANALYZER	N/A	N/A	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	51-I-001	40 75 00	No	
210	51-RO-AIT-0006	RO FEED HEADER INLET pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	51-I-001	40 75 00	No	
211	51-RO-FE-0001	RO FEED HEADER FLOW	MAGNETIC FLOWMETER	10"	N/A	mV	SEE FIT	N/A	51-I-001	40 71 00	No	
212	51-RO-FI-0001	RO FEED HEADER CONDUCTIVITY ANALYZER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY RO MFR	N/A	51-I-001	40 71 00	No	
213	51-RO-FI-0002	RO FEED HEADER TURBIDITY ANALYZER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY RO MFR	N/A	51-I-001	40 71 00	No	
214	51-RO-FI-0003	RO FEED HEADER ORP ANALYZER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY RO MFR	N/A	51-I-001	40 71 00	No	
215	51-RO-FI-0004	RO FEED HEADER FREE CHLORINE ANALYZER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY RO MFR	N/A	51-I-001	40 71 00	No	
216	51-RO-FI-0005	RO FEED HEADER MONO-CHLORIMINE / AMMONIA ANALYZER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY RO MFR	N/A	51-I-001	40 71 00	No	
217	51-RO-FI-0006	RO FEED HEADER INLET pH ANALYZER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY RO MFR	N/A	51-I-001	40 71 00	No	
218	51-RO-FIT-0001	RO FEED HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-1.30 MGD	4-WIRE	51-I-001	40 71 00	No	
219	51-RO-FSL-0001	RO FEED HEADER ANALYZER PANEL FLOW	FLOW SWITCH LOW	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-001	40 71 00	No	
220	51-RO-PDIT-0103	RO FEED PUMP 1 OUTLET CARTRIDGE FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-002	40 72 00	Yes	
221	51-RO-PDIT-0203	RO FEED PUMP 2 OUTLET CARTRIDGE FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-002	40 72 00	Yes	
222	51-RO-PDIT-0303	RO FEED PUMP 3 OUTLET CARTRIDGE FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-002	40 72 00	Yes	
223	51-RO-PG-0101	RO FEED PUMP 1 SUCTION PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-002	40 73 12	Yes	
224	51-RO-PG-0102	RO FEED PUMP 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-002	40 73 12	Yes	
225	51-RO-PG-0201	RO FEED PUMP 1 SUCTION PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-002	40 73 12	Yes	
226	51-RO-PG-0202	RO FEED PUMP 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-002	40 73 12	Yes	
227	51-RO-PG-0301	RO FEED PUMP 3 SUCTION PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-002	40 73 12	Yes	
228	51-RO-PG-0302	RO FEED PUMP 3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-002	40 73 12	Yes	
229	51-RO-PSH-0102	RO FEED PUMP 1 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-002	40 72 00	Yes	
230	51-RO-PSH-0202	RO FEED PUMP 2 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-002	40 72 00	Yes	
231	51-RO-PSH-0302	RO FEED PUMP 3 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-002	40 72 00	Yes	
232	51-RO-PSL-0101	RO FEED PUMP 1 SUCTION PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-002	40 72 00	Yes	
233	51-RO-PSL-0201	RO FEED PUMP 1 SUCTION PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-002	40 72 00	Yes	
234	51-RO-PSL-0301	RO FEED PUMP 3 SUCTION PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-002	40 72 00	Yes	
235	51-RO-AE-1001	RO UNIT 1 STAGE 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-003	40 75 00	Yes	
236	51-RO-AE-1002	RO UNIT 1 STAGE 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-003	40 75 00	Yes	
237	51-RO-AIT-1001	RO UNIT 1 STAGE 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-003	40 75 00	Yes	
238	51-RO-AIT-1002	RO UNIT 1 STAGE 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-003	40 75 00	Yes	
239	51-RO-FE-1001	RO UNIT 1 STAGE 2 PERMEATE FLOW	MAGNETIC FLOWMETER	3"	N/A	mV	SEE FIT	N/A	51-I-003	40 71 00	Yes	
240	51-RO-FIT-1001	RO UNIT 1 STAGE 2 PERMEATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-1.30 MGD	4-WIRE	51-I-003	40 71 00	Yes	
241	51-RO-PG-1001	RO UNIT 1 MEMBRANE MULTIPLE POINT SAMPLE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-003	40 73 12	Yes	
242	51-RO-PG-1004	RO UNIT 1 MEMBRANE BOOSTER PUMP OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-003	40 73 12	Yes	
243	51-RO-PIT-1001	RO UNIT 1 MEMBRANE STAGE 1 INLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-003	40 72 00	Yes	
244	51-RO-PIT-1002	RO UNIT 1 MEMBRANE STAGE 1 PERMEATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-003	40 72 00	Yes	
245	51-RO-PIT-1003	RO UNIT 1 MEMBRANE BOOSTER PUMP INLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-003	40 72 00	Yes	
246	51-RO-PIT-1004	RO UNIT 1 MEMBRANE BOOSTER PUMP OUTLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-003	40 72 00	Yes	
247	51-RO-PIT-1005	RO UNIT 1 MEMBRANE STAGE 1 CONCENTRATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-003	40 72 00	Yes	
248	51-RO-AE-2001	RO UNIT 2 STAGE 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-004	40 75 00	Yes	
249	51-RO-AE-2002	RO UNIT 2 STAGE 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-004	40 75 00	Yes	
250	51-RO-AIT-2001	RO UNIT 2 STAGE 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-004	40 75 00	Yes	
251	51-RO-AIT-2002	RO UNIT 2 STAGE 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-004	40 75 00	Yes	
252	51-RO-FE-2001	RO UNIT 2 STAGE 2 PERMEATE FLOW	MAGNETIC FLOWMETER	3"	N/A	mV	SEE FIT	N/A	51-I-004	40 71 00	Yes	
253	51-RO-FIT-2001	RO UNIT 2 STAGE 2 PERMEATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-1.30 MGD	4-WIRE	51-I-004	40 71 00	Yes	
254	51-RO-PG-2001	RO UNIT 2 MEMBRANE MULTIPLE POINT SAMPLE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-004	40 73 12	Yes	
255	51-RO-PG-2004	RO UNIT 2 MEMBRANE BOOSTER PUMP OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-004	40 73 12	Yes	
256	51-RO-PIT-2001	RO UNIT 2 MEMBRANE STAGE 1 INLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-004	40 72 00	Yes	
257	51-RO-PIT-2002	RO UNIT 2 MEMBRANE STAGE 1 PERMEATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-004	40 72 00	Yes	
258	51-RO-PIT-2003	RO UNIT 2 MEMBRANE BOOSTER PUMP INLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-004	40 72 00	Yes	
259	51-RO-PIT-2004	RO UNIT 2 MEMBRANE BOOSTER PUMP OUTLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-004	40 72 00	Yes	

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
260	51-RO-PIT-2005	RO UNIT 2 MEMBRANE STAGE 1 CONCENTRATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-004	40 72 00	Yes	
261	51-RO-AE-3001	RO UNIT 3 STAGE 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-005	40 75 00	Yes	
262	51-RO-AE-3002	RO UNIT 3 STAGE 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-005	40 75 00	Yes	
263	51-RO-AIT-3001	RO UNIT 3 STAGE 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-005	40 75 00	Yes	
264	51-RO-AIT-3002	RO UNIT 3 STAGE 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-005	40 75 00	Yes	
265	51-RO-FE-3001	RO UNIT 3 STAGE 2 PERMEATE FLOW	MAGNETIC FLOWMETER	3"	N/A	mV	SEE FIT	N/A	51-I-005	40 71 00	Yes	
266	51-RO-FIT-3001	RO UNIT 3 STAGE 2 PERMEATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-005	40 71 00	Yes	
267	51-RO-PG-3001	RO UNIT 3 MEMBRANE MULTIPLE POINT SAMPLE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-005	40 73 12	Yes	
268	51-RO-PG-3004	RO UNIT 3 MEMBRANE BOOSTER PUMP OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-005	40 73 12	Yes	
269	51-RO-PIT-3001	RO UNIT 3 MEMBRANE STAGE 1 INLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-005	40 72 00	Yes	
270	51-RO-PIT-3002	RO UNIT 3 MEMBRANE STAGE 1 PERMEATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-005	40 72 00	Yes	
271	51-RO-PIT-3003	RO UNIT 3 MEMBRANE BOOSTER PUMP INLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-005	40 72 00	Yes	
272	51-RO-PIT-3004	RO UNIT 3 MEMBRANE BOOSTER PUMP OUTLET PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-005	40 72 00	Yes	
273	51-RO-PIT-3005	RO UNIT 3 MEMBRANE STAGE 1 CONCENTRATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-005	40 72 00	Yes	
274	51-RO-AE-1003	RO UNIT 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-006	40 75 00	Yes	
275	51-RO-AE-1004	RO UNIT 1 CONCENTRATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-006	40 75 00	Yes	
276	51-RO-AIT-1003	RO UNIT 1 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-006	40 75 00	Yes	
277	51-RO-AIT-1004	RO UNIT 1 CONCENTRATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-006	40 75 00	Yes	
278	51-RO-FE-1002	RO UNIT 1 PERMEATE FLOW	MAGNETIC FLOWMETER	4"	N/A	mV	SEE FIT	N/A	51-I-006	40 71 00	Yes	
279	51-RO-FE-1003	RO UNIT 1 CONCENTRATE FLOW	MAGNETIC FLOWMETER	2.5"	N/A	mV	SEE FIT	N/A	51-I-006	40 71 00	Yes	
280	51-RO-FIT-1002	RO UNIT 1 PERMEATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-006	40 71 00	Yes	
281	51-RO-FIT-1003	RO UNIT 1 CONCENTRATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-006	40 71 00	Yes	
282	51-RO-PG-1006	RO UNIT 1 PERMEATE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-30 PSI	N/A	51-I-006	40 73 12	Yes	
283	51-RO-PG-1007	RO UNIT 1 CONCENTRATE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	51-I-006	40 73 12	Yes	
284	51-RO-PIT-1006	RO UNIT 1 PERMEATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-006	40 72 00	Yes	
285	51-RO-PIT-1007	RO UNIT 1 CONCENTRATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-006	40 72 00	Yes	
286	51-RO-PIT-1008	RO UNIT 1 CONCENTRATE TO OUTFALL PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-006	40 72 00	Yes	
287	51-RO-PSH-1006	RO UNIT 1 PERMEATE PRESSURE HIGH	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-006	40 72 00	Yes	
288	51-RO-AE-2003	RO UNIT 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-007	40 75 00	Yes	
289	51-RO-AE-2004	RO UNIT 2 CONCENTRATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-007	40 75 00	Yes	
290	51-RO-AIT-2003	RO UNIT 2 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-007	40 75 00	Yes	
291	51-RO-AIT-2004	RO UNIT 2 CONCENTRATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-007	40 75 00	Yes	
292	51-RO-FE-2002	RO UNIT 2 PERMEATE FLOW	MAGNETIC FLOWMETER	4"	N/A	mV	SEE FIT	N/A	51-I-007	40 71 00	Yes	
293	51-RO-FE-2003	RO UNIT 2 CONCENTRATE FLOW	MAGNETIC FLOWMETER	2.5"	N/A	mV	SEE FIT	N/A	51-I-007	40 71 00	Yes	
294	51-RO-FIT-2002	RO UNIT 2 PERMEATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-007	40 71 00	Yes	
295	51-RO-FIT-2003	RO UNIT 2 CONCENTRATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-007	40 71 00	Yes	
296	51-RO-PG-2006	RO UNIT 2 PERMEATE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-30 PSI	N/A	51-I-007	40 73 12	Yes	
297	51-RO-PG-2007	RO UNIT 2 CONCENTRATE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	51-I-007	40 73 12	Yes	
298	51-RO-PIT-2006	RO UNIT 2 PERMEATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-007	40 72 00	Yes	
299	51-RO-PIT-2007	RO UNIT 2 CONCENTRATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-007	40 72 00	Yes	
300	51-RO-PIT-2008	RO UNIT 2 CONCENTRATE TO OUTFALL PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-007	40 72 00	Yes	
301	51-RO-PSH-2006	RO UNIT 2 PERMEATE HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-007	40 72 00	Yes	
302	51-RO-AE-3003	RO UNIT 3 PERMEATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-008	40 75 00	Yes	
303	51-RO-AE-3004	RO UNIT 3 CONCENTRATE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	51-I-008	40 75 00	Yes	
304	51-RO-AIT-3003	RO UNIT 3 PERMEATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-008	40 75 00	Yes	
305	51-RO-AIT-3004	RO UNIT 3 CONCENTRATE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	51-I-008	40 75 00	Yes	
306	51-RO-FE-3002	RO UNIT 3 PERMEATE FLOW	MAGNETIC FLOWMETER	4"	N/A	mV	SEE FIT	N/A	51-I-008	40 71 00	Yes	
307	51-RO-FE-3003	RO UNIT 3 CONCENTRATE FLOW	MAGNETIC FLOWMETER	2.5"	N/A	mV	SEE FIT	N/A	51-I-008	40 71 00	Yes	
308	51-RO-FIT-3002	RO UNIT 3 PERMEATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-008	40 71 00	Yes	
309	51-RO-FIT-3003	RO UNIT 3 CONCENTRATE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-008	40 71 00	Yes	
310	51-RO-PG-3006	RO UNIT 3 PERMEATE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-30 PSI	N/A	51-I-008	40 73 12	Yes	
311	51-RO-PG-3007	RO UNIT 3 CONCENTRATE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	51-I-008	40 73 12	Yes	
312	51-RO-PIT-3006	RO UNIT 3 PERMEATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-008	40 72 00	Yes	
313	51-RO-PIT-3007	RO UNIT 3 CONCENTRATE PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-008	40 72 00	Yes	
314	51-RO-PIT-3008	RO UNIT 3 CONCENTRATE TO OUTFALL PRESSURE	PRESSURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-008	40 72 00	Yes	
315	51-RO-PSH-3006	RO UNIT 3 PERMEATE HIGH PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-008	40 72 00	Yes	
316	51-CIP-AE-0201	NEUTRALIZATION TANK pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	51-I-009	40 75 00	Yes	
317	51-CIP-AIT-0201	NEUTRALIZATION TANK Ph	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	51-I-009	40 75 00	Yes	
318	51-CIP-FE-0101	RO PERMEATE TO CIP MAKE UP TANK FLOW	MAGNETIC FLOWMETER	3"	N/A	mV	SEE FIT	N/A	51-I-009	40 71 00	No	
319	51-CIP-FIT-0101	RO PERMEATE TO CIP MAKE UP TANK FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-009	40 71 00	No	
320	51-CIP-LG-0101	CIP MAKEUP TANK LEVEL	LEVEL SIGHT GLASS	N/A	N/A	N/A	0-5.0 FT	N/A	51-I-009	26 05 11	Yes	
321	51-CIP-LG-0201	NEUTRALIZATION TANK LEVEL	LEVEL SIGHT GLASS	N/A	N/A	N/A	0-5.0 FT	N/A	51-I-009	26 05 11	Yes	
322	51-CIP-LIT-0101	CIP MAKEUP TANK LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-5.0 FT	2-WIRE	51-I-009	40 72 00	Yes	
323	51-CIP-LIT-0201	NEUTRALIZATION TANK LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-5.0 FT	2-WIRE	51-I-009	40 72 00	Yes	
324	51-CIP-LSH-0001	RO CIP AREA SUMP HIGH LEVEL	FLOOD LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 2" INCREASING	N/A	51-I-009	26 05 11	No	
325	51-CIP-LSH-0101	CIP MAKEUP TANK HIGH LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 4.5 FT INCREASING	N/A	51-I-009	26 05 11	Yes	
326	51-CIP-LSH-0201	NEUTRALIZATION TANK HIGH LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 4.5 FT INCREASING	N/A	51-I-009	26 05 11	Yes	
327	51-CIP-LSL-0101	CIP MAKEUP TANK LOW LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 1.5 FT DECREASING	N/A	51-I-009	26 05 11	Yes	
328	51-CIP-LSL-0201	NEUTRALIZATION TANK LOW LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 1.5 FT DECREASING	N/A	51-I-009	26 05 11	Yes	
329	51-RO-FSH-0001	RO BUILDING EYEWASH FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	51-I-009	22 00 00	No	
330	51-CIP-AE-0001	CIP PUMP DISCHARGE HEADER pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	51-I-010	40 75 00	Yes	
331	51-CIP-AIT-0001	CIP PUMP DISCHARGE HEADER pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	51-I-010	40 75 00	Yes	
332	51-CIP-FE-0001	CIP PUMP DISCHARGE HEADER FLOW	MAGNETIC FLOWMETER	6"	N/A	mV	SEE FIT	N/A	51-I-010	40 71 00	No	
333	51-CIP-FIT-0001	CIP PUMP DISCHARGE HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-010	40 71 00	No	
334	51-CIP-PDG-0001	CIP PUMP DISCHARGE CARTRIDGE FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	BY RO MFR	N/A	51-I-010	40 73 12	Yes	
335	51-CIP-PDSH-0001	CIP PUMP DISCHARGE CARTRIDGE FILTER HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH HIGH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-010	40 72 00	Yes	
336	51-CIP-PG-0101	CIP PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	51-I-010	40 73 12	Yes	
337	51-CIP-PG-0201	CIP PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	51-I-010	40 73 12	Yes	

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
338	51-CIP-PSH-0001	CIP PUMP DISCHARGE HEADER PRESSURE HIGH	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY RO MFR	N/A	51-I-010	40 72 00	Yes	
339	51-CIP-TE-0001	CIP PUMP DISCHARGE HEADER TEMP ELEMENT	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	mV	SEE TIT	N/A	51-I-010	40 74 00	Yes	
340	51-CIP-TIT-0001	CIP PUMP DISCHARGE HEADER TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	2-WIRE	51-I-010	40 74 00	Yes	
341	51-RO-FE-0002	RO FLUSH PUMP DISCHARGE HEADER FLOW	MAGNETIC FLOWMETER	4"	N/A	mV	SEE FIT	N/A	51-I-011	40 71 00	No	
342	51-RO-FIT-0002	RO FLUSH PUMP DISCHARGE HEADER FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY RO MFR	4-WIRE	51-I-011	40 71 00	No	
343	51-RO-LG-0001	RO FLUSH TANK LEVEL	LEVEL SIGHT GLASS	N/A	N/A	N/A	0-10.5 FT (EL 106.50-117.00)	N/A	51-I-011	26 05 11	Yes	
344	51-RO-LIT-0001	RO FLUSH TANK LEVEL	PRESSURE SENSING LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-10.5 FT (EL 106.50-117.00)	2-WIRE	51-I-011	40 72 00	Yes	
345	51-RO-LSH-0001	RO FLUSH TANK HIGH LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @10.5 FT INCREASING	N/A	51-I-011	26 05 11	Yes	
346	51-RO-LSL-0001	RO FLUSH TANK LOW LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 2.0 FT DECREASING	2-WIRE	51-I-011	40 72 00	Yes	
347	51-RO-PG-0103	RO FLUSH PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-011	40 73 12	Yes	
348	51-RO-PG-0203	RO FLUSH PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY RO MFR	N/A	51-I-011	40 73 12	Yes	
349	52-UV-AE-0002	UV/AOP SYSTEM INLET pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	52-I-001	40 75 00	No	
350	52-UV-AE-0004	UV/AOP SYSTEM INLET FREE RESIDUAL CHLORINE	CHLORINE RESIDUAL SENSOR	N/A	N/A	mV	SEE AIT	N/A	52-I-001	40 75 00	No	
351	52-UV-AE-0005	UV/AOP SYSTEM INLET UV TRANSMITTANCE	UV SENSOR	N/A	N/A	mV	SEE AIT	N/A	52-I-001	40 75 00	No	
352	52-UV-AE-0007	UV/AOP SYSTEM OUTLET pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	52-I-001	40 75 00	No	
353	52-UV-AIT-0002	UV/AOP SYSTEM INLET PH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	52-I-001	40 75 00	No	
354	52-UV-AIT-0004	UV/AOP SYSTEM INLET FREE RESIDUAL CHLORINE	CHLORINE RESIDUAL ANALYZER	N/A	N/A	4-20mA	0-10 mg/L	4-WIRE	52-I-001	40 75 00	No	
355	52-UV-AIT-0005	UV/AOP SYSTEM INLET UV TRANSMITTANCE	UV ANALYZER	N/A	N/A	4-20mA	BY UV AOP MFR	4-WIRE	52-I-001	40 75 00	No	
356	52-UV-AIT-0007	UV/AOP SYSTEM OUTLET pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	52-I-001	40 75 00	No	
357	52-UV-FE-0001	UV/AOP SYSTEM DISCHARGE HEADER FLOW	MAGNETIC FLOWMETER	8"	N/A	mV	SEE FIT	N/A	52-I-001	40 71 00	No	
358	52-UV-FG-0001	UV/AOP SYSTEM INLET TOTAL RESIDUAL CHLORINE SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
359	52-UV-FG-0002	UV/AOP SYSTEM INLET pH SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
360	52-UV-FG-0003	UV/AOP SYSTEM INLET TOTAL CHLORINE SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
361	52-UV-FG-0004	UV/AOP SYSTEM INLET FREE RESIDUAL CHLORINE SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
362	52-UV-FG-0005	UV/AOP SYSTEM INLET UVT SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
363	52-UV-FG-0006	UV/AOP SYSTEM OUTLET UVT SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
364	52-UV-FG-0007	UV/AOP SYSTEM OUTLET pH SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
365	52-UV-FG-0008	UV/AOP SYSTEM OUTLET FREE CHLORINE SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
366	52-UV-FG-0009	UV/AOP SYSTEM OUTLET TOTAL CHLORINE SAMPLE FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY UV AOP MFR	N/A	52-I-001	40 71 00	No	
367	52-UV-FIT-0001	UV/AOP SYSTEM DISCHARGE HEADER FLOW	FLOW INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-1.00 MGD	4-WIRE	52-I-001	40 71 00	No	
368	61-CAL-FE-0001	BACKWASH HOLDING TANK SEWER FLOW	MAGNETIC FLOWMETER	3"	N/A	mV	SEE FIT	N/A	61-I-001	40 71 00	No	
369	61-CAL-FIT-0001	BACKWASH HOLDING TANK SEWER FLOW	FLOW INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-300 GPM	4-WIRE	61-I-001	40 71 00	No	
370	61-CAL-LIT-0001	BACKWASH WASTE HOLDING TANK LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-XX FT	2-WIRE	61-I-001	40 72 00	No	XX = 100% FULL BELOW INVERT OF OVERFLOW PIPE
371	61-CAL-PDG-0101	CALCITE FILTER VESSEL 1 DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	0-20 PSI	N/A	61-I-001	40 73 12	Yes	
372	61-CAL-PDG-0201	CALCITE FILTER VESSEL 2 DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	0-20 PSI	N/A	61-I-001	40 73 12	Yes	
373	61-CAL-PDSH-0101	CALCITE FILTER VESSEL 1 HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 10 PSI INCREASING	N/A	61-I-001	40 72 00	Yes	
374	61-CAL-PDSH-0201	CALCITE FILTER VESSEL 2 HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 10 PSI INCREASING	N/A	61-I-001	40 72 00	Yes	
375	61-CAL-PG-0001	CALCITE FILTER VESSEL 1 INLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	61-I-001	40 73 12	Yes	
376	61-CAL-PG-0002	CALCITE FILTER VESSEL 1 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	61-I-001	40 73 12	Yes	
377	61-CAL-PG-0003	CALCITE FILTER VESSEL 2 INLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	61-I-001	40 73 12	Yes	
378	61-CAL-PG-0004	CALCITE FILTER VESSEL 2 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	61-I-001	40 73 12	Yes	
379	61-CAL-PG-0005	CALCITE SYSTEM BACKWASH FLUSH PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-30 PSI	N/A	61-I-001	40 73 12	Yes	
380	61-CAL-AE-0001	CALCITE FILTER INLET HEADER pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	61-I-001	40 75 00	Yes	
381	61-CAL-AIT-0001	CALCITE FILTER INLET HEADER pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	61-I-001	40 75 00	Yes	
382	61-CAL-AE-0002	CALCITE FILTER OUTLET HEADER pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	61-I-001	40 75 00	Yes	
383	61-CAL-AIT-0002	CALCITE FILTER OUTLET HEADER pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	61-I-001	40 75 00	Yes	
384	62-TW-LIT-0001	PRODUCT WATER TANK LEVEL	PRESSURE SENSING TYPE LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-19.0 FT (EL 104.00-123.00	2-WIRE	62-I-001	40 72 00	No	
385	62-TW-LSHH-0001	PRODUCT WATER TANK HIGH-HIGH LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 18.75 FT INCREASING	N/A	62-I-001	40 72 00	No	
386	62-TW-LSLL-0001	PRODUCT WATER TANK LOW-LOW LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 3 FT DECREASING	N/A	62-I-001	40 72 00	No	
387	63-TW-AE-0001	STORAGE TANK DISCHARGE TOTAL RESIDUAL CHLORINE	CHLORINE RESIDUAL SENSOR	N/A	N/A	mV	SEE AIT	N/A	63-I-001	40 75 00	No	
388	63-TW-AE-0002	STORAGE TANK DISCHARGE CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	63-I-001	40 75 00	No	
389	63-TW-AE-0003	STORAGE TANK DISCHARGE pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	63-I-001	40 75 00	No	
390	63-TW-AIT-0001	STORAGE TANK DISCHARGE TOTAL RESIDUAL CHLORINE	CHLORINE RESIDUAL ANALYZER	N/A	N/A	4-20mA	0-10 mg/L	N/A	63-I-001	40 75 00	No	
391	63-TW-AIT-0002	STORAGE TANK DISCHARGE CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	N/A	63-I-001	40 75 00	No	
392	63-TW-AIT-0003	STORAGE TANK DISCHARGE pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	N/A	63-I-001	40 75 00	No	
393	63-TW-FE-0001	IPR PUMP STATION DISCHARGE HEADER FLOW ELEMENT	MAGNETIC FLOWMETER	6"	N/A	mV	SEE FIT	N/A	63-I-001	40 71 00	No	
394	63-TW-FIT-0001	IPR PUMP STATION DISCHARGE HEADER FLOW	FLOW INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-1.00 MGD	4-WIRE	63-I-001	40 71 00	No	
395	63-TW-PG-0101	IPR PUMP NO.1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	63-I-001	40 73 12	No	
396	63-TW-PG-0201	IPR PUMP NO.2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	63-I-001	40 73 12	No	
397	63-TW-PG-0301	IPR PUMP NO.3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-200 PSI	N/A	63-I-001	40 73 12	No	
398	63-TW-PIT-0001	IPR PUMP STATION DISCHARGE HEADER PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-100 PSI	2-WIRE	63-I-001	40 72 00	No	
399	63-TW-PSH-0101	IPR PUMP NO.1 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 80 PSI INCREASING	N/A	63-I-001	40 72 00	No	
400	63-TW-PSH-0201	IPR PUMP NO.2 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 80 PSI INCREASING	N/A	63-I-001	40 72 00	No	
401	63-TW-PSH-0301	IPR PUMP NO.3 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 80 PSI INCREASING	N/A	63-I-001	40 72 00	No	
402	64-TW-FE-0001	OUTFALL PUMP STATION DISCHARGE HEADER FLOW	MAGNETIC FLOWMETER	12"	N/A	mV	SEE FIT	N/A	64-I-001	40 71 00	No	
403	64-TW-FIT-0001	OUTFALL PUMP STATION DISCHARGE HEADER FLOW	FLOW INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-7,500 GPM	4-WIRE	64-I-001	40 71 00	No	
404	64-TW-LIT-0001	OUTFALL BALANCING TANK LEVEL	PRESSURE SENSING TYPE LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-18 FT (EL 104.00-122.00)	2-WIRE	64-I-001	40 72 00	No	
405	64-TW-LSH-0001	OUTFALL BALANCING TANK HIGH LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 18 FT INCREASING	N/A	64-I-001	40 72 00	No	
406	64-TW-LSL-0001	OUTFALL BALANCING TANK LOW LEVEL	PRESSURE SENSING TYPE LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 3 FT DECREASING	2-WIRE	64-I-001	40 72 00	No	

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
407	64-TW-PG-0101	OUTFALL PUMP NO.1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	64-I-001	40 73 12	No	
408	64-TW-PG-0201	OUTFALL PUMP NO.2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	64-I-001	40 73 12	No	
409	64-TW-PG-0301	OUTFALL PUMP NO.3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	64-I-001	40 73 12	No	
410	64-TW-PG-0401	OUTFALL PUMP NO.4 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	64-I-001	40 73 12	No	
411	64-TW-PIT-0001	OUTFALL PUMP STATION DISCHARGE HEADER PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-100 PSI	2-WIRE	64-I-001	40 72 00	No	
412	64-TW-PSH-0101	OUTFALL PUMP NO.1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 42 PSI INCREASING	N/A	64-I-001	40 72 00	No	
413	64-TW-PSH-0201	OUTFALL PUMP NO.2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 42 PSI INCREASING	N/A	64-I-001	40 72 00	No	
414	64-TW-PSH-0301	OUTFALL PUMP NO.3 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 40 PSI INCREASING	N/A	64-I-001	40 72 00	No	
415	64-TW-PSH-0401	OUTFALL PUMP NO.4 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 40 PSI INCREASING	N/A	64-I-001	40 72 00	No	
416	65-TW-AE-0004	OUTFALL PUMP STATION DISCHARGE HEADER FREE CHLORINE	CHLORINE RESIDUAL SENSOR	N/A	N/A	mV	SEE AIT	N/A	65-I-001	40 75 00	No	
417	65-TW-AIT-0004	OUTFALL PUMP STATION DISCHARGE HEADER FREE CHLORINE	CHLORINE RESIDUAL ANALYZER	N/A	N/A	4-20mA	0-10 mg/L	N/A	65-I-001	40 75 00	No	
418	71-WAS-AE-0101	SLUDGE HOLDING TANK NO.1 DISSOLVED OXYGEN	DISSOLVED OXYGEN SENSOR	N/A	N/A	mV	SEE AIT	N/A	71-I-001	40 75 00	No	
419	71-WAS-AE-0201	SLUDGE HOLDING TANK NO.2 DISSOLVED OXYGEN	DISSOLVED OXYGEN SENSOR	N/A	N/A	mV	SEE AIT	N/A	71-I-001	40 75 00	No	
420	71-WAS-AIT-0101	SLUDGE HOLDING TANK NO.1 DISSOLVED OXYGEN	DISSOLVED OXYGEN ANALYZER	N/A	N/A	4-20mA	0-20 mg/L	4-WIRE	71-I-001	40 75 00	No	
421	71-WAS-AIT-0201	SLUDGE HOLDING TANK NO.2 DISSOLVED OXYGEN	DISSOLVED OXYGEN ANALYZER	N/A	N/A	4-20mA	0-20 mg/L	4-WIRE	71-I-001	40 75 00	No	
422	71-WAS-LIT-0101	SLUDGE HOLDING TANK NO.1 RADAR LEVEL	RADAR LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-23.0 FT (EL 111.25-134.25)	2-WIRE	71-I-001	40 72 00	No	
423	71-WAS-LIT-0201	SLUDGE HOLDING TANK NO.2 RADAR LEVEL	RADAR LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-23.0 FT (EL 111.25-134.25)	2-WIRE	71-I-001	40 72 00	No	
424	71-WAS-LE-0001	SAFE SETTLE TANK LEVEL	ULTRASONIC LEVEL SENSOR	N/A	N/A	mV	SEE LIT	N/A	71-I-002	40 72 00	No	
425	71-WAS-LIT-0001	SAFE SETTLE TANK LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-23 FT (EL 111.00-134.00)	4-WIRE	71-I-002	40 72 00	No	
426	71-AIR-PDG-0101	SLUDGE HOLDING TANK BLOWER NO 1 INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	0-10 in. w.c.	N/A	71-I-003	40 72 00	Yes	
427	71-AIR-PDG-0201	SLUDGE HOLDING TANK BLOWER NO 2 INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	N/A	N/A	N/A	0-10 in. w.c.	N/A	71-I-003	40 72 00	Yes	
428	71-AIR-PDSH-0101	SLUDGE HOLDING TANK BLOWER NO 2 INLET FILTER HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH HIGH	N/A	N/A	DRY CONTACT	TRIP @ 2 in. w.c.	N/A	71-I-003	40 72 00	Yes	
429	71-AIR-PDSH-0201	SLUDGE HOLDING TANK BLOWER NO 2 INLET FILTER HIGH DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH HIGH	N/A	N/A	DRY CONTACT	TRIP @ 2 in. w.c.	N/A	71-I-003	40 72 00	Yes	
430	71-AIR-PG-0101	SLUDGE HOLDING TANK BLOWER NO 1 INLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	30 in. Hg VAC-15 PSI	N/A	71-I-003	40 73 12	Yes	
431	71-AIR-PG-0102	SLUDGE HOLDING TANK BLOWER NO 1 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	30 in. Hg VAC-15 PSI	N/A	71-I-003	40 73 12	Yes	
432	71-AIR-PG-0201	SLUDGE HOLDING TANK BLOWER NO 2 INLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-15 PSI	N/A	71-I-003	40 73 12	Yes	
433	71-AIR-PG-0202	SLUDGE HOLDING TANK BLOWER NO 2 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-15 PSI	N/A	71-I-003	40 73 12	Yes	
434	71-AIR-PIT-0102	SLUDGE HOLDING TANK BLOWER NO 1 OUTLET PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-15 PSI	2-WIRE	71-I-003	40 72 00	No	
435	71-AIR-PIT-0202	SLUDGE HOLDING TANK BLOWER NO 2 OUTLET PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-15 PSI	2-WIRE	71-I-003	40 72 00	No	
436	71-AIR-PSH-0102	SLUDGE HOLDING TANK BLOWER NO 1 HIGH OUTLET PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 10.3 PSI	N/A	71-I-003	40 72 00	Yes	
437	71-AIR-PSH-0202	SLUDGE HOLDING TANK BLOWER NO 2 HIGH OUTLET PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 10.3 PSI	N/A	71-I-003	40 72 00	Yes	
438	71-AIR-TDSH-0101	SLUDGE HOLDING TANK BLOWER NO 1 HIGH OUTLET DIFFERENTIAL TEMPERATURE	DIFFERENTIAL TEMPERATURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	71-I-003	40 74 00	Yes	
439	71-AIR-TDSH-0201	SLUDGE HOLDING TANK BLOWER NO 2 HIGH OUTLET DIFFERENTIAL TEMPERATURE	DIFFERENTIAL TEMPERATURE SWITCH	N/A	N/A	DRY CONTACT	BY BLOWER MFR	N/A	71-I-003	40 74 00	Yes	
440	71-AIR-TG-0101	SLUDGE HOLDING TANK BLOWER NO 1 OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	N/A	0-200 F	N/A	71-I-003	40 74 00	Yes	
441	71-AIR-TG-0201	SLUDGE HOLDING TANK BLOWER NO 2 OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	N/A	0-200 F	N/A	71-I-003	40 74 00	Yes	
442	72-DWT-FE-0001	DEWATERING SLUDGE FEED PUMP DISCHARGE HEADER FLOW	MAGNETIC FLOWMETER	6"	N/A	mV	SEE FIT	N/A	72-I-001	40 71 00	Yes	
443	72-DWT-FIT-0001	DEWATERING SLUDGE FEED PUMP DISCHARGE HEADER FLOW	FLOW INDICATING TRANSMITTER	N/A	N/A	4-20mA	0-350 GPM	4-WIRE	72-I-001	40 71 00	Yes	
444	72-DWT-FSL-0101	DEWATERING SLUDGE FEED PUMP NO 1 SEAL WATER LOW FLOW	FLOW SWITCH LOW	N/A	N/A	DRY CONTACT	BY PUMP MFR	N/A	72-I-001	43 05 21	Yes	
445	72-DWT-FSL-0201	DEWATERING SLUDGE FEED PUMP NO 2 SEAL WATER LOW FLOW	FLOW SWITCH LOW	N/A	N/A	DRY CONTACT	BY PUMP MFR	N/A	72-I-001	43 05 21	Yes	
446	72-DWT-PG-0102	DEWATERING SLUDGE FEED PUMP NO 1 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	72-I-001	40 73 12	Yes	
447	72-DWT-PG-0202	DEWATERING SLUDGE FEED PUMP NO 2 OUTLET PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	72-I-001	40 73 12	Yes	
448	72-DWT-PSH-0102	DEWATERING SLUDGE FEED PUMP NO 1 HIGH OUTLET PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 45 PSI	N/A	72-I-001	40 72 00	Yes	
449	72-DWT-PSH-0202	DEWATERING SLUDGE FEED PUMP NO 2 HIGH OUTLET PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 45 PSI	N/A	72-I-001	40 72 00	Yes	
450	72-DWT-PSL-0101	DEWATERING SLUDGE FEED PUMP NO 1 LOW SUCTION PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 5" Hg VAC DECREASING	N/A	72-I-001	40 72 00	Yes	
451	72-DWT-PSL-0201	DEWATERING SLUDGE FEED PUMP NO 2 LOW SUCTION PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 5" Hg VAC DECREASING	N/A	72-I-001	40 72 00	Yes	
452	72-DWT-PSL-0001	BELT FILTER PRESS WASHWATER PUMP DISCHARGE LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY BFP MFR	N/A	72-I-002	40 72 00	Yes	
453	72-DWT-SS-0001	SCREW CONVEYOR 1 ZERO SPEED	SPEED SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 0 RPM	N/A	72-I-002	40 78 00	Yes	
454	72-DWT-SS-0002	SCREW CONVEYOR 2 ZERO SPEED	SPEED SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 0 RPM	N/A	72-I-002	40 78 00	Yes	
455	72-DWT-SS-0003	SCREW CONVEYOR 3 ZERO SPEED	SPEED SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 0 RPM	N/A	72-I-002	40 78 00	Yes	
456	73-FSW-AE-0001	DISK FILTER pH	pH SENSOR	N/A	N/A	mV	SEE AIT	N/A	73-I-001	40 75 00	Yes	
457	73-FSW-AIT-0001	DISK FILTER pH	pH ANALYZER	N/A	N/A	4-20mA	0-14 pH	4-WIRE	73-I-001	40 75 00	Yes	
458	73-FSW-FE-0001	DISK FILTER FLOW TO OUTFALL FLOW	MAGNETIC FLOWMETER	14"	N/A	mV	SEE FIT	N/A	73-I-001	40 71 00	No	
459	73-FSW-FE-0002	FILTER SOLID WASTE PUMP DISCHARGE FLOW	MAGNETIC FLOWMETER	6"	N/A	mV	SEE FIT	N/A	73-I-001	40 71 00	Yes	
460	73-FSW-FE-0003	FILTER SOLID WASTE PUMP DISCHARGE FLOW	MAGNETIC FLOWMETER	6"	N/A	mV	SEE FIT	N/A	73-I-001	40 71 00	Yes	
461	73-FSW-FIT-0001	DISK FILTER FLOW TO OUTFALL FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	BY FILTER MFR	4-WIRE	73-I-001	40 71 00	No	
462	73-FSW-FIT-0002	FILTER SOLID WASTE PUMP DISCHARGE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-500 GPM	4-WIRE	73-I-001	40 71 00	Yes	
463	73-FSW-FIT-0003	FILTER BACKWASH WASTE PUMP DISCHARGE FLOW	MAGNETIC FLOWMETER TRANSMITTER	N/A	N/A	4-20mA	0-500 GPM	4-WIRE	73-I-001	40 71 00	Yes	
464	73-FSW-FS-0001	DISK FILTER FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY FILTER MFR	N/A	73-I-001	40 71 00	Yes	
465	73-FSW-LE-0001	DISK FILTER LEVEL	PRIMARY LEVEL ELEMENT/SENSOR	N/A	N/A	mV	BY FILTER MFR	N/A	73-I-001	46 61 41	Yes	
466	73-FSW-LIT-0001	DISK FILTER LEVEL	PRESSURE SENSING LEVEL TRANSMITTER	N/A	N/A	4-20mA	BY FILTER MFR	2-WIRE	73-I-001	46 61 41	Yes	
467	73-FSW-LSH-0001	DISK FILTER HIGH LEVEL	LEVEL SWITCH HIGH	N/A	N/A	DRY CONTACT	BY FILTER MFR	N/A	73-I-001	46 61 41	Yes	
468	73-FSW-PG-0003	FILTER SOLID WASTE PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY FILTER MFR	N/A	73-I-001	40 73 12	Yes	
469	73-FSW-PG-0004	FILTER BACKWASH WASTE PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY FILTER MFR	N/A	73-I-001	40 73 12	Yes	
470	73-FSW-PIT-0001	FILTER SOLID WASTE PUMP SUCTION PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	BY FILTER MFR	2-WIRE	73-I-001	40 72 00	Yes	
471	73-FSW-PIT-0002	FILTER BACKWASH WASTE PUMP SUCTION PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	N/A	4-20mA	BY FILTER MFR	2-WIRE	73-I-001	40 72 00	Yes	
472	73-FSW-PSH-0003	FILTER SOLID WASTE PUMP DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY FILTER MFR	N/A	73-I-001	40 72 00	Yes	
473	73-FSW-PSH-0004	FILTER BACKWASH WASTE PUMP DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	BY FILTER MFR	N/A	73-I-001	40 72 00	Yes	
474	73-FSW-VIT-0001	DISK FILTER VIBRATION	VIBRATION TRANSMITTER	N/A	N/A	4-20mA	BY FILTER MFR	2-WIRE	73-I-001	46 61 41	Yes	
475	81-FO-AAX-0001	GENERATOR ALARM	ALARM HORN	N/A	N/A	N/A	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
476	81-FO-HMS-0001	GENERATOR ALARM SILENCE	MOMENTARY PUSHBUTTON	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
477	81-FO-HS-0001	GENERATOR E-STOP	PUSH BUTTON	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
478	81-FO-LI-0001	GENERATOR FUEL TANK LOCAL LEVEL	LEVEL INDICATOR	N/A	N/A	N/A	SEE LIT	N/A	81-I-001	40 72 00	Yes	
479	81-FO-LIT-0001	GENERATOR FUEL TANK LEVEL	LEVEL INDICATING TRANSMITTER	N/A	N/A	4-20mA	BY ENG GEN MFR	2-WIRE	81-I-001	26 32 13	Yes	
480	81-FO-LSH-0001	GENERATOR FUEL TANK HIGH LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
481	81-FO-LSH-0002	GENERATOR SECONDARY CONATAINMENT HIGH LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
482	81-FO-LSHH-0001	GENERATOR FUEL TANK HIGH-HIGH LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
483	81-FO-LSL-0001	GENERATOR FUEL TANK LOW LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
484	81-FO-TSH-0001	GENERATOR FUEL TANK HIGH TEMPERATURE	DIFFERENTIAL TEMPERATURE SWITCH	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
485	81-FO-TSL-0001	GENERATOR FUEL TANK LOW TEMPERATURE	DIFFERENTIAL TEMPERATURE SWITCH	N/A	N/A	DRY CONTACT	BY ENG GEN MFR	N/A	81-I-001	26 32 13	Yes	
486	90-NOCL-AAX-0001	SODIUM HYPOCHLORITE STORAGE TANK ALARM	ALARM HORN	N/A	N/A	DRY CONTACT	N/A	N/A	90-I-001	40 78 00	No	
487	90-NOCL-FSH-0001	SODIUM HYPOCHLORITE AREA EYEWASH FLOW SWITCH	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-001	22 00 00	No	
488	90-NOCL-LAH-0001	SODIUM HYPOCHLORITE STORAGE TANK HIGH LEVEL	INDICATING LIGHT	N/A	N/A	N/A	N/A	N/A	90-I-001	40 78 00	No	
489	90-NOCL-LI-0001	SODIUM HYPOCHLORITE STORAGE TANK LEVEL	ELECTRONIC BAR GRAPH INDICATOR	N/A	N/A	DRY CONTACT	0-100% FULL	N/A	90-I-001	40 78 00	No	100% FULL IS BELOW INVERT OF OVERFLOW PIPE
490	90-NOCL-LIT-0001	SODIUM HYPOCHLORITE STORAGE TANK LEVEL	FLANGE-MOUNTED PRESSURE SENSING LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-100% FULL	2-WIRE	90-I-001	40 72 00	No	100% FULL IS BELOW INVERT OF OVERFLOW PIPE
491	90-NOCL-LSH-0001	SODIUM HYPOCHLORITE STORAGE TANK HIGH LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX FT INCREASING	N/A	90-I-001	40 72 00	No	XX = 100% FULL BELOW INVERT OF OVERFLOW PIPE
492	90-NOCL-LSH-0002	SODIUM HYPOCHLORITE STORAGE TANK CONTAINMENT SUMP HIGH LEVEL	FLOOD LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 2" INCREASING	N/A	90-I-001	40 72 00	No	
493	90-NOCL-PG-0101	SODIUM HYPOCHLORITE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-001	40 73 12	Yes	
494	90-NOCL-PG-0102	SODIUM HYPOCHLORITE METERING PUMP NO 1 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-001	40 73 12	Yes	
495	90-NOCL-PG-0201	SODIUM HYPOCHLORITE METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-001	40 73 12	Yes	
496	90-NOCL-PG-0202	SODIUM HYPOCHLORITE METERING PUMP NO 2 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-001	40 73 12	Yes	
497	90-NOCL-PG-0301	SODIUM HYPOCHLORITE METERING PUMP NO 3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-001	40 73 12	Yes	
498	90-NOCL-PG-0302	SODIUM HYPOCHLORITE METERING PUMP NO 3 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-001	40 73 12	Yes	
499	90-NOCL-PSH-0101	SODIUM HYPOCHLORITE METERING PUMP NO 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-001	40 72 00	Yes	XX IS PER METERING PUMP MFR.
500	90-NOCL-PSH-0201	SODIUM HYPOCHLORITE METERING PUMP NO 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-001	40 72 00	Yes	XX IS PER METERING PUMP MFR.
501	90-NOCL-PSH-0301	SODIUM HYPOCHLORITE METERING PUMP NO 3 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-001	40 72 00	Yes	XX IS PER METERING PUMP MFR.
502	95-CHEM-LSH-0001	CHEMICAL HAND HOLE N1 HIGH LEVEL	LEVEL SWITCH HIGH	N/A	N/A	DRY CONTACT	TRIP @ x.x FT INCREASING	N/A	90-I-001	41 72 00	No	
503	90-NOCL-PG-0401	SODIUM HYPOCHLORITE METERING PUMP NO 4 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
504	90-NOCL-PG-0402	SODIUM HYPOCHLORITE METERING PUMP NO 4 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
505	90-NOCL-PG-0501	SODIUM HYPOCHLORITE METERING PUMP NO 5 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
506	90-NOCL-PG-0502	SODIUM HYPOCHLORITE METERING PUMP NO 5 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
507	90-NOCL-PG-0601	SODIUM HYPOCHLORITE METERING PUMP NO 6 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
508	90-NOCL-PG-0602	SODIUM HYPOCHLORITE METERING PUMP NO 6 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
509	90-NOCL-PG-0701	SODIUM HYPOCHLORITE METERING PUMP NO 7 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
510	90-NOCL-PG-0702	SODIUM HYPOCHLORITE METERING PUMP NO 7 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-002	40 73 12	Yes	
511	90-NOCL-PSH-0401	SODIUM HYPOCHLORITE METERING PUMP NO 4 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-002	40 72 00	Yes	XX IS PER METERING PUMP MFR.
512	90-NOCL-PSH-0501	SODIUM HYPOCHLORITE METERING PUMP NO 5 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-002	40 72 00	Yes	XX IS PER METERING PUMP MFR.
513	90-NOCL-PSH-0601	SODIUM HYPOCHLORITE METERING PUMP NO 6 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-002	40 72 00	Yes	XX IS PER METERING PUMP MFR.
514	90-NOCL-PSH-0701	SODIUM HYPOCHLORITE METERING PUMP NO 7 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-002	40 72 00	Yes	XX IS PER METERING PUMP MFR.
515	90-NAOH-AAX-0001	SODIUM HYDROXIDE STORAGE TANK ALARM	ALARM HORN	N/A	N/A	DRY CONTACT	N/A	N/A	90-I-003	40 78 00	No	
516	90-NAOH-FSH-0001	SODIUM HYDROXIDE STORAGE TANK AREA EYEWASH FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-003	22 00 00	No	
517	90-NAOH-LAH-0001	SODIUM HYDROXIDE STORAGE TANK HIGH LEVEL	INDICATING LIGHT	N/A	N/A	N/A	N/A	N/A	90-I-003	40 78 00	No	
518	90-NAOH-LI-0001	SODIUM HYDROXIDE STORAGE TANK LEVEL	ELECTRONIC BAR GRAPH INDICATOR	N/A	N/A	DRY CONTACT	0-100% FULL	N/A	90-I-003	40 78 00	No	100% FULL IS BELOW INVERT OF OVERFLOW PIPE
519	90-NAOH-LIT-0001	SODIUM HYDROXIDE STORAGE TANK LEVEL	FLANGE-MOUNTED PRESSURE SENSING LEVEL TRANSMITTER	N/A	N/A	4-20mA	0-100% FULL	2-WIRE	90-I-003	40 72 00	No	100% FULL IS BELOW INVERT OF OVERFLOW PIPE
520	90-NAOH-LSH-0001	SODIUM HYDROXIDE STORAGE TANK HIGH LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX FT INCREASING	N/A	90-I-003	40 72 00	No	XX = 100% FULL BELOW INVERT OF OVERFLOW PIPE
521	90-NAOH-LSH-0002	SODIUM HYDROXIDE STORAGE TANK CONTAINMENT SUMP LEVEL HIGH	FLOOD LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 2" INCREASING	N/A	90-I-003	40 72 00	No	
522	90-NAOH-PG-0101	SODIUM HYDROXIDE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-003	40 73 12	Yes	
523	90-NAOH-PG-0102	SODIUM HYDROXIDE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-003	40 73 12	Yes	
524	90-NAOH-PG-0201	SODIUM HYDROXIDE METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-003	40 73 12	Yes	
525	90-NAOH-PG-0202	SODIUM HYDROXIDE METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-003	40 73 12	Yes	
526	90-NAOH-PG-0301	SODIUM HYDROXIDE METERING PUMP NO 3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-003	40 73 12	Yes	
527	90-NAOH-PG-0302	SODIUM HYDROXIDE METERING PUMP NO 3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-003	40 73 12	Yes	
528	90-NAOH-PSH-0101	SODIUM HYDROXIDE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	0-60 PSI	N/A	90-I-003	40 72 00	Yes	
529	90-NAOH-PSH-0201	SODIUM HYDROXIDE METERING PUMP NO 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-003	40 72 00	Yes	XX IS PER METERING PUMP MFR.
530	90-NAOH-PSH-0301	SODIUM HYDROXIDE METERING PUMP NO 3 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-003	40 72 00	Yes	XX IS PER METERING PUMP MFR.
531	90-NHS-FSH-0001	SODIUM BISULFITE STORAGE AREA EYEWASH FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-004	22 00 00	No	
532	90-NHS-PG-0001	SODIUM BISULFITE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-004	40 73 12	Yes	
533	90-NHS-PG-0002	SODIUM BISULFITE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-004	40 73 12	Yes	
534	90-NHS-PSH-0001	SODIUM BISULFITE METERING PUMP NO 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-004	40 72 00	Yes	XX IS PER METERING PUMP MFR.
535	90-NHS-WE-0001	SODIUM BISULFITE STORAGE TOTE 1 WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-004	43 40 40	No	
536	90-NHS-WE-0002	SODIUM BISULFITE STORAGE TOTE 2 WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-004	43 40 40	No	
537	90-NHS-WIT-0001	SODIUM BISULFITE STORAGE TOTE 1 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-004	43 40 40	No	
538	90-NHS-WIT-0002	SODIUM BISULFITE STORAGE TOTE 2 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-004	43 40 40	No	
539	90-NHS-PG-0003B608:I	SODIUM BISULFITE METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-004	40 73 12	Yes	
540	90-NHS-PG-0004	SODIUM BISULFITE METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-004	40 73 12	Yes	
541	90-NHS-PSH-0002	SODIUM BISULFITE METERING PUMP NO 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-004	40 72 00	Yes	XX IS PER METERING PUMP MFR.
542	95-CHEM-LSH-0002	CHEMICAL HAND HOLE S5 HIGH LEVEL	LEVEL SWITCH HIGH	N/A	N/A	DRY CONTACT	TRIP @ x.x FT INCREASING	N/A	90-I-004	41 72 00	No	
543	90-ANTI-FSH-0001	ANTISCALANT STORAGE AREA EYEWASH FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-005	22 00 00	No	
544	90-ANTI-PG-0001	ANTISCALANT METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-005	40 73 12	Yes	
545	90-ANTI-PG-0002	ANTISCALANT METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-005	40 73 12	Yes	
546	90-ANTI-PSH-0001	ANTISCALANT METERING PUMP NO 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-005	40 72 00	Yes	XX IS PER METERING PUMP MFR.

INSTRUMENT DEVICE SCHEDULE - MORRO BAY WRF

Item	Tag	Service Description	Device Type	Primary Flow Element Size	Instrument Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Provided by a Supplier	Remarks
547	90-ANTI-WE-0001	ANTISCALANT STORAGE TOTE 1 WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-005	43 40 40	No	
548	90-ANTI-WE-0002	ANTISCALANT STORAGE TOTE 2 WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-005	43 40 40	No	
549	90-ANTI-WIT-0001	ANTISCALANT STORAGE TOTE 1 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-005	43 40 40	No	
550	90-ANTI-WIT-0002	ANTISCALANT STORAGE TOTE 2 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-005	43 40 40	No	
551	90-CA-FSH-0001	CITRIC ACID STORAGE AREA EYEWASH FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-006	22 00 00	No	
552	90-CA-PG-0101	CITRIC ACID METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-006	40 73 12	Yes	
553	90-CA-PG-0102	CITRIC ACID METERING PUMP NO 1 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-006	40 73 12	Yes	
554	90-CA-PG-0201	CITRIC ACID METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-006	40 73 12	Yes	
555	90-CA-PG-0202	CITRIC ACID METERING PUMP NO 2 PULSATION DAMPNER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-006	40 73 12	Yes	
556	90-CA-PSH-0101	CITRIC ACID METERING PUMP NO 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-006	40 72 00	Yes	XX IS PER METERING PUMP MFR.
557	90-CA-PSH-0201	CITRIC ACID METERING PUMP NO 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-006	40 72 00	Yes	XX IS PER METERING PUMP MFR.
558	90-CA-WE-0001	CITRIC ACID STORAGE TOTE 1 WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-006	43 40 40	No	
559	90-CA-WE-0002	CITRIC ACID STORAGE TOTE 2 WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-006	43 40 40	No	
560	90-CA-WIT-0001	CITRIC ACID STORAGE TOTE 1 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-006	43 40 40	No	
561	90-CA-WIT-0002	CITRIC ACID STORAGE TOTE 2 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-006	43 40 40	No	
562	90-HSO4-AE-0101	SUFURIC ACID DILUTION WATER CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	90-I-007	43 40 40	Yes	
563	90-HSO4-AE-0201	SUFURIC ACID DILUTION WATER CONDUCTIVITY	CONDUCTIVITY SENSOR - ELECTRODE TYPE	N/A	N/A	mV	SEE AIT	N/A	90-I-007	43 40 40	Yes	
564	90-HSO4-AIT-0101	SUFURIC ACID DILUTION WATER CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	90-I-007	43 40 40	Yes	
565	90-HSO4-AIT-0201	SUFURIC ACID DILUTION WATER CONDUCTIVITY	CONDUCTIVITY ANALYZER - ELECTRODE TYPE	N/A	N/A	4-20mA	0-50 uS/M	4-WIRE	90-I-007	43 40 40	Yes	
566	90-HSO4-FSH-0001	SULFURIC ACID STORAGE AREA EYEWASH FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-007	22 00 00	No	
567	90-HSO4-PG-0101	SULFURIC ACID METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	90-I-007	40 73 12	Yes	
568	90-HSO4-PG-0102	SULFURIC ACID METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	90-I-007	40 73 12	Yes	
569	90-HSO4-PG-0201	SULFURIC ACID METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	90-I-007	40 73 12	Yes	
570	90-HSO4-PG-0202	SULFURIC ACID METERING PUMP NO 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-100 PSI	N/A	90-I-007	40 73 12	Yes	
571	90-HSO4-PSH-0101	SULFURIC ACID METERING PUMP NO 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-007	40 72 00	Yes	XX IS PER METERING PUMP MFR.
572	90-HSO4-PSH-0201	SULFURIC ACID METERING PUMP NO 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-007	40 72 00	Yes	XX IS PER METERING PUMP MFR.
573	90-HSO4-TE-0101	SUFURIC ACID DILUTION WATER TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	mV	SEE TIT	N/A	90-I-007	43 40 40	Yes	
574	90-HSO4-TE-0201	SUFURIC ACID DILUTION WATER TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	mV	SEE TIT	N/A	90-I-007	43 40 40	Yes	
575	90-HSO4-TIT-0101	SUFURIC ACID DILUTION WATER TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	N/A	4-20mA	0-120 F	2-WIRE	90-I-007	43 40 40	Yes	
576	90-HSO4-TIT-0201	SUFURIC ACID DILUTION WATER TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	N/A	4-20mA	0-120 F	2-WIRE	90-I-007	43 40 40	Yes	
577	90-HSO4-WE-0001	SULFURIC ACID STORAGE TOTE 1 WEIGHT SENSOR	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-007	43 40 40	No	
578	90-HSO4-WE-0002	SULFURIC ACID STORAGE TOTE 2 WEIGHT SENSOR	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-007	43 40 40	No	
579	90-HSO4-WIT-0001	SULFURIC ACID STORAGE TOTE 1 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-007	43 40 40	No	
580	90-HSO4-WIT-0002	SULFURIC ACID STORAGE TOTE 2 WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	4-WIRE	90-I-007	43 40 40	No	
581	90-NPW-FI-0101	SUFURIC ACID DILUTION WATER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY SULFURIC ACID SUPPLIER	N/A	90-I-007	43 40 40	Yes	
582	90-NPW-FI-0201	SUFURIC ACID DILUTION WATER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY SULFURIC ACID SUPPLIER	N/A	90-I-007	43 40 40	Yes	
583	90-NPW-FI-0001	POLYMER DILUTION WATER FLOW	LIQUID SERVICE ROTAMETER	N/A	N/A	N/A	BY SULFURIC ACID SUPPLIER	N/A	90-I-008	40 71 00	No	
584	90-NPW-PG-0001	THICKENING POLYMER DILUTION WATER PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	BY POLYMER MFR	N/A	90-I-008	40 73 12	No	
585	90-NPW-PSL-0001	THICKENING POLYMER DILUTION WATER LOW PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI DECREASING	N/A	90-I-008	40 72 00	Yes	XX IS PER METERING PUMP MFR.
586	90-POLF-FSH-0001	THICKENING POLYMER STORAGE AREA EYEWASH FLOW	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-008	22 00 00	No	
587	90-POLF-ISH-0001	THICKENING POLYMER TOTE MIXER HIGH CURRENT	CURRENT HIGH SWITCH	N/A	N/A	DRY CONTACT	BY MIXER MFR	N/A	90-I-008	40 72 00	No	
588	90-POLF-PG-0001	THICKENING POLYMER METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-008	40 73 12	Yes	
589	90-POLF-WE-0001	THICKENING POLYMER STORAGE TOTE WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-008	43 40 40	No	
590	90-POLF-WIT-0001	THICKENING POLYMER STORAGE TOTE WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	2-WIRE	90-I-008	43 40 40	No	
591	90-LAS-FSH-0001	LIQUID AMMONIUM SULFATE STORAGE AREA EYEWASH FLOW SWITCH	FLOW SWITCH	N/A	N/A	DRY CONTACT	BY EYEWASH MFR	N/A	90-I-009	22 00 00	No	
592	90-LAS-PG-0001	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-009	40 73 12	Yes	
593	90-LAS-PG-0002	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	4-1/2"	N/A	0-60 PSI	N/A	90-I-009	40 73 12	Yes	
594	90-LAS-PSH-0001	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	N/A	DRY CONTACT	TRIP @ XX PSI INCREASING	N/A	90-I-009	40 72 00	Yes	XX IS PER METERING PUMP MFR.
595	90-LAS-WE-0001	LIQUID AMMONIUM SULFATE STORAGE TOTE WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-009	43 40 40	No	
596	90-LAS-WE-0002	LIQUID AMMONIUM SULFATE STORAGE TOTE WEIGHT	WEIGHT SENSOR	N/A	N/A	mV	SEE WIT	N/A	90-I-009	43 40 40	No	
597	90-LAS-WIT-0001	LIQUID AMMONIUM SULFATE STORAGE TOTE WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	2-WIRE	90-I-009	43 40 40	No	
598	90-LAS-WIT-0002	LIQUID AMMONIUM SULFATE STORAGE TOTE WEIGHT	WEIGHT TRANSMITTER	N/A	N/A	4-20mA	0-3,000 LBS	2-WIRE	90-I-009	43 40 40	No	
599	95-SAN-LSH-0001	SANITARY LIFT PUMPING STATION HIGH LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 6.0 FT INCREASING	N/A	95-I-001	40 72 00	Yes	
600	95-SAN-LSHH-0001	SANITARY LIFT PUMPING STATION HIGH-HIGH LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 7.0 FT INCREASING	N/A	95-I-001	40 72 00	Yes	
601	95-SAN-LSL-0001	SANITARY LIFT PUMPING STATION LOW LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	BY PUMP MFR	N/A	95-I-001	40 72 00	Yes	
602	95-SAN-LSM-0001	SANITARY LIFT PUMPING STATION MID LEVEL	LEVEL SWITCH	N/A	N/A	DRY CONTACT	TRIP @ 4.0 FT INCREASING	N/A	95-I-001	40 72 00	Yes	
603	95-PW-YS-0001	POTABLE WATER TEMPER SWITCH	TEMPER SWITCH	N/A	N/A	DRY CONTACT	TRIP @ x.x	N/A	95-I-001		No	

END

Section 40 62 00

COMPUTER SYSTEM HARDWARE

PART 1 – GENERAL

1-1. SCOPE. This section covers the furnishing and installation of standard computer system hardware fully configured to work with the software specified in the Computer System Software section. Principal items of the computer and peripheral hardware to be furnished are specified or are indicated on the control system block diagram on the Drawings.

System Supplier shall furnish all necessary interconnecting cables, accessories, and appurtenances as well as additional computer or peripheral hardware required for proper operation and to meet the functional requirements indicated on the Drawings and specified herein.

All equipment shall be capable of tolerating and "riding through" a power interruption of 8 milliseconds or less without interruption of normal operation.

1-1.02. Control System. Section Instrumentation and Control System shall apply to all computer hardware furnished under this section.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System section .

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System section.

1-5. SPARE PARTS. The System Supplier shall provided a list of recommended spare parts and pricing per the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. SYSTEM COMPUTERS. System Supplier shall ensure that all computers are configured to operate properly with all software, input/output devices, and peripherals supplied.

2-1.01. Server Computers. Each Server Computer shall be comprised of the following configuration. This configuration is to be provided as a minimum:

Processor type.	Quad Core Intel Xeon
Processor speed.	3.6 GHz
Monitor type.	LCD with LED backlight, 16:9 aspect ratio
Monitor size.	21 inch
Memory size (RAM).	16 GB
Number of Ethernet cards.	2
Enclosure style.	19" rack-mount
Manufacturer.	Dell, Hewlett Packard Enterprise

Two (2) 300 GB SATA hard drives with integrated RAID controller.

Single CPU (with dual CPU capabilities).

16X DVD-ROM.

Integrated VGA compatible video controller.

10 MB Cache.

Six hot-pluggable hard drive bays.

Redundant power supplies.

Scroll Mouse.

Standard Windows keyboard.

2 Serial Ports standard.

1 Parallel Ports standard.

4 USB Ports.

2-1.01.01. Magnetic Storage Device. Not used.

2-1.01.02. Removable Hard Drive. A removable hard drive shall be supplied and shall be capable of storing a minimum of 80 GB of data on a removable cartridge. The drive shall be internally or externally mounted. The drive shall be Iomega Jaz, Castlewood Orb, or equal.

2-1.01.03. DLT Tape. Not used.

2-1.01.04. CD/DVD-RW Drive. A DVD-RW (read/write) drive shall be supplied and shall be capable of Orange Book standard with a minimum of 20x read and 16x record and of playing DVD disks. DVD drive shall be manufactured by HP, Sony, Panasonic or equal. DVD drives shall be supplied with spare disks.

2-1.01.05. Serial Communications Port Expander. Not used.

2-1.02. Workstation Computers. Each Workstation Computer shall be comprised of the following configuration. This configuration is to be provided as a minimum:

Processor type.	Dual-Core (Intel Xeon or AMD Opteron)
Processor speed.	3.8 Ghz
Monitor type.	Flat Panel LCD with LED backlight
Monitor size.	21 inch
Memory size (RAM).	8 GB
Manufacturer.	Dell, Hewlett Packard
500 GB SATA hard drive.	
Single CPU.	
CD/DVD ROM.	
256 MB AGP video card.	
2 MB Cache.	
One 10/100/1000 Mbps RJ-45 connectivity Ethernet cards.	
Scroll mouse.	
Standard Windows keyboard.	
1 Parallel Ports standard.	
4 USB Ports	
Sound Card and speakers.	

2-1.02.01. Magnetic Storage Device. Not used.

2-1.02.02. CD-RW/DVD Drive. The CD-RW (read/write)/DVD drive shall be supplied and shall be capable of Orange Book standard with a minimum of 32x read and 8x record and of playing DVD disks. CD-RW/DVD drive shall be manufactured by HP, Sony, Panasonic or equal. CD-RW/DVD drives shall be supplied with spare disks.

2-1.03. Notebook Computer. A notebook computer shall be provided. The notebook computer shall be configured as a minimum of a Intel Core i7 processor, minimum 2.8 GHz processor speed, with a 14.1" TFT display, 8 GB of RAM, one 500 GB hard drive, CD/DVD-RW, video controller with 1 GB of memory, and Ethernet card that supports 10/100/1000 Mbps RJ-45 connectivity, and integrated sound. The notebook computer shall be provided with a lithium ion battery to provide a minimum of three hours of use. The notebook computer shall be a Dell Latitude, Toshiba Tecra, or equal.

Each notebook computer shall be provided with a docking station with the following features:

Integral 10/100/1000 Base-TX Ethernet connection

Two (2) 3.3V and 5V PCI expansion slots

Monitor and monitor stand

Locking mechanism

Standard I/O ports – serial, parallel, video, mouse, keyboard, USB

Standard Windows keyboard

Two/Three button Intellimouse

2-1.04. Industrial Computers. Each Industrial Computer shall be comprised of the following configuration. This configuration is to be provided as a minimum:

Processor type.	Dual-Core (Intel Xeon or AMD Opteron)
Processor speed.	3.8 Ghz
Monitor type.	Flat Panel LCD touchscreen with LED backlight
Monitor size.	15 inch
Memory size (RAM).	8 GB
Manufacturer.	Dell, Hewlett Packard, Wonderware, CP Technologies

500 GB SATA hard drive.

Single CPU.

CD/DVD ROM.

256 MB AGP video card.

2 MB Cache.

One 10/100/1000 Mbps RJ-45 connectivity Ethernet cards.

Scroll mouse.

Standard Windows keyboard.

1 Parallel Ports standard.

4 USB Ports

Sound Card and speakers.

2-2. SYSTEM PRINTERS.

2-2.01. Alarms and Events Printers. Not used.

2-2.02. Report Printer. Laser type printer(s) for printing reports shall be provided, and shall be capable of printing on letter, legal, and tabloid sized sheets of standard paper. The printer shall accept paper fed manually or from one of two paper trays, each with a minimum capacity of 200 sheets.

The report printer shall print at least 35 pages of text per minute at a resolution of 1200 dpi or greater. The printer shall contain a minimum of 48 MB of on-board RAM, expandable to 320 MB. The report printer shall be a Hewlett Packard LaserJet Enterprise M500 series series or equal.

Report printer(s) shall be provided with a 10/100/1000 Base-TX interface to provide connectivity to the computers over the Ethernet network.

2-2.03. Color Graphics Printer. Color graphics printer(s) for producing color plots of process graphic screens, trends, and charts shall be provided and shall be of color inkjet type. Color graphics printers shall not require the use of thermally sensitive, chemically treated, or other special paper, and shall meet at least the following minimum requirements:

Shall be capable of delivering 20 pages per minute at the best color quality print speed.

Shall utilize at least 4 separate color print heads for accurate color reproduction.

Shall have a print quality of 1200 x 1200 dpi in the color print mode.

Color graphics printer(s) shall be Hewlett Packard OfficeJet Pro 8000 Series or equal.

The color graphics printer shall be provided with a 10/100Base-TX interface to provide connectivity to the computers over the Ethernet network.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. Installation, field check, testing and training shall be as described in the Instrumentation and Control System section.

End of Section

Section 40 64 00

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 – GENERAL

1-1. SCOPE. This section covers the alternate/optional pricing programmable logic controllers (PLCs), including associated input/output hardware to control process equipment and serve as the interface to field devices.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all equipment furnished under this section. Additional PLC software requirements are indicated in Software Control Block Descriptions section.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings and equipment specifications indicate the number and types of PLCs, locations of PLCs, who is providing the PLCs and provide diagrams and schematics regarding connection and interaction with other equipment. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the Drawings.

1-2.03. I/O List. An input/output (I/O) field device signal listing is included as an appendix attached to this section.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System, Submittal Procedures, and Schedule of Submittals sections.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System Section.

1-5. SPARE PARTS. The System Supplier shall provide spare parts per the general Terms and Conditions

PART 2 - PRODUCTS

2-1. GENERAL. All equipment furnished under this section shall be expressly selected by System Supplier for its superior quality for the intended purpose and shall comply with the following requirements.

2-1.01. Interchangeability. All programmable logic controller systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules such as coprocessors and ASCII modules shall be interchangeable among all I/O panels and systems. PLC modules and hardware by other manufacturers will be acceptable only if the PLC manufacturer does not offer suitable modules and hardware for the same functions.

2-1.02. Initial, Spare, and Future Memory (RAM). System Supplier shall provide adequate memory for the amount of I/O, control algorithms, and communications in the initial system.

Each programmable logic controller shall include provisions for future expansion and shall have 100 percent spare memory capacity and 100 percent spare data capacity installed. The spare memory capacity shall be documented by submitting to Design-Builder, during factory testing, a statement indicating the amounts of memory of all types being utilized and the total amount available in each system. The statement shall include an estimate of the total program and data memory necessary, including spare memory, based on the I/O hardware for the system, and previous programming experience.

2-1.03. Spare I/O. Each PLC input/output enclosure shall be provided with at least 20 percent spare inputs and outputs of each type. Spare I/O shall be installed, wired, and interfaced properly to the terminal strip. The spare I/O shall be in addition to any I/O installed and reserved for future process signals as may be indicated on the I/O list. In addition, each PLC input/output enclosure shall be capable of accommodating 25 percent of additional input/output capacity of each type as originally assembled, without the need for additional expansion racks, communication adapters, cables, or PLC power supplies.

2-1.04. Expandability. Each PLC processor and associated I/O shall have a future expandability of at least 50 percent of the provided system.

2-1.05. Acceptable Manufacturers. The PLCs shall be Allen-Bradley (A-B), without exception.

2-1.06. Signal Power Supplies. Regulated dc power supplies shall be provided in each PLC enclosure for analog inputs, digital outputs, digital inputs. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or protected against short-circuiting. Output voltage

regulation shall be as required by the instrumentation equipment supplied under another section.

The loop power supply shall be separate from the power supply circuit for the processor and racks.

The power source for all digital inputs from field devices shall be separately fused for each digital input module. Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

2-1.07. Appurtenances. The PLC processor and I/O hardware shall be provided as complete systems, as shown on the control system block diagram drawings. The PLCs shall include all necessary hardware and software for a complete working system. All special rack or panel mounted power supplies, special interconnecting and programming cables, special grounding hardware, or isolation devices shall be furnished for proper operation of the equipment. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, intrinsically safe relays and current repeaters, surge suppression devices, and isolation devices shall be furnished and installed for proper operation of the equipment.

PLC and RIO panel power supplies shall provide 24-volt dc power for all of the 24-volt dc powered instruments, either loop-powered or 4-wired devices.

2-1.08. PLC Arrangement. The PLCs shall be distributed and arranged as indicated on the Drawings. PLC I/O for duty/standby equipment from separate process trains shall be connected to separate I/O modules.

2-1.09. Service Conditions. PLCs will be installed in air conditioned rooms, non air conditioned room, or outdoors where the ambient temperature range is 6-22°C. PLCs shall be furnished with sun shades and air conditioned and heated enclosures.

2-2. LARGE PLC PROCESSOR. The Allen-Bradley ControlLogix programmable logic controller processor shall be an industrial-type rack-mounted unit that utilizes battery-backed CMOS type or nonvolatile type memory. Battery backed memory shall include integral batteries with sufficient capacity for at least 6 months' memory retention without power to the processing unit. Standby and shelf life of the batteries shall be at least 5 years.

The system shall include an Erasable Programmable Read Only Memory (EPROM) card for storage of the user program. The processor shall automatically download the user program from the EPROM upon startup after a

power loss. The EPROM shall be programmable by the PLC or PLC software, without the use of external PROM programmable equipment.

2-2.01. Diagnostics. The processor shall utilize self-monitoring diagnostic techniques and shall contain easily visible LED diagnostic indicators for "run" and "halt" conditions as well as memory and input/output error conditions. Diagnostic codes shall also be available through the programming device to facilitate troubleshooting.

2-2.02. Programming Port. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional, and after all communications, human machine interface (HMI), and network connections have been made. Removal or disruption of network communications, remote I/O communications, and HMIs to allow for on-line programming and monitoring will not be acceptable. A key switch shall be provided on the processor for selection of the operating mode and as a security measure.

2-2.03. Communications. The processor shall be programmed to operate autonomously, regardless of communications status with other units. Each programmable controller shall be furnished complete with communication modules for local and remote input/output hardware communications, communications with other programmable controllers, and communication with host computers as shown on the block diagram.

2-2.04. Environment. The processor shall be suitable for operation in the environments specified in another section.

2-2.05. Programming. The processor shall be programmable using Allen-Bradley RSLogix Stuido Professional Edition the IEC 61131 international programming standards and ladder logic programming. IEC 61131 programming shall include the following:

Functional Block Diagram

Functional Block Diagram programming shall include a minimum of the following capabilities:

Contacts, coils, branching.

Data comparisons.

On-delay and off-delay timers.

Counters with comparators.

Floating point Math and Logical instructions.

PID loop control.

Jumps and Subroutine functions.

Master control relay.

Transitional or one-shot outputs.

Standard and user-defined data tables for digital and analog value storage.

Remote I/O capability.

Fault-mode sub-routine.

2-2.06. Programming Capabilities. The processor shall include the following capabilities for programming, debugging of programs, and troubleshooting.

Off-line programming.

On-line programming.

On-line status of coils and registers.

Input/output forcing.

2-2.07. Hardware Configuration. Processors shall be configured for standard rack mounting. Each programmable logic controller processor shall include integral communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces.

2-2.08. Input/Output Hardware. Input/output hardware shall be arranged as indicated on the Drawings. Programmable logic controller systems shall support the following types of input/output modules.

24 volt dc digital input and output.

4-20 mA dc analog input and output.

Platinum RTD analog input.

All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will not be acceptable.

2-2.08.01. Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2-2.08.02. I/O Circuit Power Supply. Outputs for motor driven equipment will typically be powered from the driven equipment. Digital outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the Drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate either interposing relays or relay-type digital output modules in the PLC cabinet.

2-2.08.03. Digital Input Modules. Digital input modules shall sense voltages between 20 and 28 volts dc and shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Return voltage may be common to the entire input module. Digital input modules shall provide complete electrical isolation between individual inputs. Digital input modules shall have multiple inputs.

2-2.08.04. Digital Output Modules. Digital output modules shall control voltages from 20 and 28 volts dc and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2.0 mA. Digital output modules shall provide complete electrical isolation between individual output circuits. Digital output modules shall have multiple outputs.

2-2.08.05. Relay Digital Output Modules. Not used.

2-2.08.06. Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Analog to digital conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog input modules shall have multiple inputs. Each input shall be fully isolated from the other inputs.

2-2.08.07. Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600-ohm load. Digital to analog conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog output modules shall have multiple outputs.

2-2.08.08. Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2-2.08.09. Interposing Relays. Interposing relays shall be incorporated on all I/O circuits as shown on the PLC input/output listing, where required by the application of isolate foreign power sources, where the continuous output rating

of the PLC relay digital or output module is not sufficient to power the connected device or equipment, or where otherwise required by the System Supplier's equipment. Interposing relays shall be provided for any digital output module output signal that leaves the PLC enclosure. Interposing relays shall be mounted in the PLC enclosure containing the output module that activates the relays.

2-3. MINI PLC PROCESSOR. The Allen-Bradley CompactLogix programmable logic controller processor shall be an industrial type that utilizes battery-backed CMOS type or non-volatile type memory. Battery-backed memory shall include integral batteries with sufficient capacity for at least 6 months' memory retention without power to the processing unit. Standby and shelf life of the batteries shall be at least 5 years.

2-3.01. Diagnostics. The processor shall utilize self-monitoring diagnostic techniques. Easily visible LEDs shall indicate "run" and "halt" status as well as memory and input/output error conditions. Diagnostic codes shall also be available through the programming device to facilitate troubleshooting.

2-3.02. Programming Port. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional. Removal or disruption of network communications, remote I/O communications, or HMIs to permit programming and monitoring will not be acceptable.

2-3.03. Communications. The processor shall be programmed to operate autonomously, regardless of communications status with other units.

2-3.04. Environment. The processor shall be suitable for operation in the environments specified in another section. A key switch shall be provided on the processor to select the operating mode and as a security measure.

2-3.05. Programming. The processor shall be programmable using conventional relay ladder logic, or as required, and shall include the following functions and features.

Contacts, coils, branching.

Data comparisons.

On-delay and off-delay timers.

Counters with comparators.

Floating Point Math and Logical instructions.

Master control relay.

Transitional or one-shot outputs.

Standard and user-defined data tables for digital and analog value

storage.

2-3.06. Capabilities. The processor shall include the following capabilities for programming, debug of programs, and troubleshooting.

Off-line programming.

On-line status of coils and registers.

Input/output forcing.

2-3.07. Configuration. Processors shall be configured for standard rack mounting and shall be of plug-in printed circuit board construction. Each programmable logic controller shall include integral communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces as required.

Programmable logic controller systems shall support the following types of input/output.

24-volt dc digital input and output.

4-20 mA dc analog input and output.

2-3.08. Input/Output Hardware. Input/output hardware shall be supplied in standard modules of 4, 8, 16, or 32 points each for assembly in local and remote input/output enclosures.

All input/output hardware shall be entirely contained within the PLC enclosure.

Programmable logic controllers having fixed, non-removable input/output hardware are not acceptable.

All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices as required and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet all of the requirements in the following subparagraphs.

2-3.08.01. Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2-3.08.02. I/O Circuit Power Supply. Outputs for motor driven equipment will typically be powered from the driven equipment. Digital outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the Drawings or as coordinated with the

controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate relay-type digital output modules or interposing relays in the PLC cabinet.

2-3.08.03. Digital Input Modules. Digital input modules shall sense voltages between 20 and 28 volts dc and shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Return voltage may be common to the entire input module. Digital input modules shall provide complete electrical isolation between individual inputs.

2-3.08.04. Digital Output Modules. Digital output modules shall control voltages from 20 and 28 volts dc and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Each digital output shall be provided with an interposing relay. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2.0 mA. Digital input modules shall provide complete electrical isolation between individual inputs.

2-3.08.05. Relay Digital Output Modules. Not used.

2-3.08.06. Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Input circuitry shall be floating differential type designed to prevent loop grounding. Analog to digital conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Where analog input signals are grounded outside of the PLC enclosure, isolation shall be provided for the associated analog input point either on the analog input module or through an I/I signal isolator provided in the PLC enclosure.

2-3.08.07. Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600 ohm load. Digital to analog conversion accuracy shall be at least 12-bit (0-4095 count) resolution.

2-3.08.08. Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2-4. COMMUNICATIONS. Each programmable controller system shall be furnished complete with communication hardware modules for local input/output hardware, remote input/output hardware, other programmable controllers, or for host computers.

Communication hardware shall be compatible with the cable, data highway, fiber optic, or radio communication media. Ethernet components and cable are specified in other specification sections.

2-4.01. Addressability. Each programmable logic controller shall be individually addressable so that only the selected controller responds when queried. At least 64 distinct network addresses shall be available. IP addressing shall be used. Designation of a controller's network address may be either a software or hardware function.

2-4.02. Communications Hardware. System Supplier shall provide all necessary communications hardware. Hardware shall be included for, but not be limited to, remote I/O, data highway, host computer, fiber optics, Ethernet and radio.

2-4.02.01. PLC to PLC Communications Hardware. Each PLC shall communicate to other PLCs over a network as shown on the control system block diagram. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2-4.02.02. PLC to Remote I/O Communications Hardware. The master PLC shall communicate with the remote PLC rack over a remote I/O communications network. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2-4.02.03. PLC to Host Communications Hardware. Each PLC shall communicate to the host computer over a network as shown on the control system block diagram. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system. The computer system hardware is covered in another section.

2-4.03. Communications Media. System Supplier shall provide all necessary cabling for the PLC communications network and PLC remote I/O communications network. Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules. PLC communications media shall be as specified under the Network Systems section.

2-5. MEDIA CONVERTERS. Not used.

2-6. TELEPHONE NETWORKS. Not used

2-7. SERIAL NETWORKS. Not used.

2-8. PROGRAMMING DEVICE HARDWARE. The programming device shall be a portable laptop computer as specified in the Computer System Hardware section. System Supplier shall provide two interconnecting cables, each 5 meters long, to connect the computer to the programmable logic controller. The cables shall be shielded data cable and shall be terminated on both ends with the appropriate connectors. Connectors shall be labeled to identify the connected equipment.

2-8.01. Special Devices. System Supplier shall provide two sets of any special devices (such as null modems, adapter cards, interface converters, etc.) required to establish an operational programming line between the programmable logic controllers and programming device.

2-9. PROGRAMMING SOFTWARE. System Supplier shall furnish one licensed copy of PLC programming software for the Owner and one licensed copy for the Design-Builder. The software shall be suitable for running on a laptop computer running Windows 10 operating system software. A full legal set of programming software documentation shall accompany each copy of the software. Each copy of the programming software shall include all necessary device drivers and add-on software packages.

2-9.01. Standard Product. The programming software shall be personal computer based and a standard product of the PLC manufacturer. The software shall be Rockwell Automation Studio 5000, as required.

2-9.02. PLC Simulation. Not used.

2-9.03. Programming Software Features. The programming software shall allow off-line development of all PLC-related programming, including user annotation of the program, and creation and printing of application programs and I/O cross-reference lists. Special programming tasks originally provided by System Supplier shall also be included.

On-line features shall include IEC-61131 standards program modification, ladder-logic modification, program language modification, monitoring of real-time ladder-logic execution, monitoring of program execution, monitoring and manipulation of timer and counter preset and present values, monitoring and forcing of physical I/O, and monitoring and manipulation of analog (register) and bit (binary) data table values. PLC and I/O hardware diagnostic and status information shall be accessible using the software in on-line mode.

2-10. SYSTEM ENCLOSURES. Programmable logic controllers and input/output hardware shall be housed in shop-assembled panels as indicated on the Drawings and as described in the Panels, Consoles, and Appurtenances section. Programmable logic controllers and input/output hardware shall be housed in existing panels or panels provided by others.

2-11. OPERATOR INTERFACE TERMINALS. Not used. Industrial computers specified in the Computer System Hardware section shall be used on local panels in place of operator interface terminals. The industrial computers shall use software specified in the Computer System Software section.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. PLCs installation requirements are specified in Instrumentation and Control System section except as described herein.

Field check, testing, and training shall be as specified in the Instrumentation and Control System section.

3-2. CONFIGURATION.

3-2.01. PLC Programming and Configuration. Configuration services are specified in the Instrumentation and Control System section.

3-2.02. Communications Configuration. The communications shall be fully configured and installed by System Supplier. Communications shall be configured as shown on the Drawings.

End of Section

INPUT/OUTPUT LIST - MORRO BAY WRF

Input/Output List - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only.

Inp+A6:L26ut/Output List - Legend/Description Sheet

AI = Analog Input
AO = Analog Output
DI = Discrete Input
DO = Discrete Output
PI = Pulse Input (totalizer or accumulator type input)

Description. This is the description or the function (i.e. Filter No. 1 Loss-of-Head).

Field Device. This is the tag number of equipment identifier associated with the I/O point.

Controller ID. This is a sequential number for a given type within a specific controller (PLC or DCU).

Analog Data (Signal Type). This will typically be 4-20mA, but could also be 1-5Vdc, serial, HART, FLD-BUS, or similar to indicate the signal type of the associated input or output.

Analog Data (Calibrated Range). This will be the scaled value of the input in engineering units.

Analog Data (Power). This will typically be '2-wire' for devices which are loop powered from the PLC enclosure, or '4-wire' for devices which are powered form external power supplies, unless noted otherwise.

Discrete Data (Signal Type). This will be 120VAC, 24VDC, or similar to indicate the signal type of the associated input or output.

Discrete Data (Closed State). This will indicate the state of the input or output when it is considered to be closed or energized (normal, alarm, running, failed, etc.).

Discrete Data (Power Source). This will indicate the location of the power source for the wetting voltage on the contacts, as follows:

Field = External field power source. (May require interposing relays or isolated I/O module type.)
Local = Power originates from within the PLC or I/O enclosure.

Discrete Data (Interp Relay). This will be either 'Yes' or 'No' to indicate whether the input or output requires an interposing relay. Relays are typically required to isolate external voltage sources. See specifications for additional details.

P&ID. This column indicates associated Process & Instrumentation Diagram.

Remarks. This column may include a cross reference to another specification section where applicable, or to a note which provides additional information. Notes are appended to the end of the I/O listing.

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
1	AI	21SCRFI0101	FLOW	INFLUENT MAIN NO 1 FLOW	21-SCR-FIT-0101	21-CTRL-RIO-0001	4-20mA	0-8.20 MGD	4-WIRE	N/A	N/A	N/A	No	21-I-001	
2	AI	21SCRFI0201	FLOW	INFLUENT MAIN NO 2 FLOW	21-SCR-FIT-0201	21-CTRL-RIO-0001	4-20mA	0-8.20 MGD	4-WIRE	N/A	N/A	N/A	No	21-I-001	
3	DI	21GRTYI1001	IN REMOTE	GRIT COLLECTOR NO 1 DISCHARGE VALVE	21-GRT-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	21-I-001	
4	DI	21GRTZIO1001	OPEN	GRIT COLLECTOR NO 1 DISCHARGE VALVE	21-GRT-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	21-I-001	
5	DI	21GRTZIC1001	CLOSED	GRIT COLLECTOR NO 1 DISCHARGE VALVE	21-GRT-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	21-I-001	
6	DI	21PRWYI1002	IN REMOTE	TRAIN NO 1 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-1002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	21-I-001	
7	DI	21PRWZIO1002	OPEN	TRAIN NO 1 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-1002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	21-I-001	
8	DI	21PRWZIC1002	CLOSED	TRAIN NO 1 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-1002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	21-I-001	
9	DI	21SCRYA0001	FAIL	BAR SCREEN NO 1 FAIL	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	FAIL	PLC	No	21-I-001	
10	DI	21SCRYI0001	IN AUTO	BAR SCREEN NO 1 IN AUTO	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN AUTO	PLC	No	21-I-001	
11	DI	21SCRLAH0001	HI LEVEL	BAR SCREEN NO 1 HI LEVEL	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	HI LEVEL	PLC	No	21-I-001	
12	DI	21SCRYA0001	ESTOP	BAR SCREEN NO 1 E-STOP	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	E-STOP	PLC	No	21-I-001	
13	DI	21SCRYIR0001	RUNNING	BAR SCREEN NO 1 RUNNING	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	No	21-I-001	
14	DI	21SCRYIR0001	LOW SPEED	BAR SCREEN NO 1 LOW SPEED	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	LOW SPEED	PLC	No	21-I-001	
15	DI	21SCRYIR0001	HIGH SPEED	BAR SCREEN NO 1 HIGH SPEED	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	HIGH SPEED	PLC	No	21-I-001	
16	DI	21SCRYI1001	IN REMOTE	HEADWORKS TRAIN NO 1 INLET VALVE	21-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	21-I-001	
17	DI	21SCRZIO1001	OPEN	HEADWORKS TRAIN NO 1 INLET VALVE	21-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	21-I-001	
18	DI	21SCRZIC1001	CLOSED	HEADWORKS TRAIN NO 1 INLET VALVE	21-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	21-I-001	
19	DI	21SCRYI2001	IN REMOTE	HEADWORKS TRAIN NO 2 INLET VALVE	21-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	21-I-001	
20	DI	21SCRZIO2001	OPEN	HEADWORKS TRAIN NO 2 INLET VALVE	21-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	21-I-001	
21	DI	21SCRZIC2001	CLOSED	HEADWORKS TRAIN NO 2 INLET VALVE	21-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	21-I-001	
22	DO	21GRTZCO1001	OPEN CMD	GRIT COLLECTOR NO 1 DISCHARGE VALVE	21-GRT-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	21-I-001	
23	DO	21GRTZCC1001	CLOSE CMD	GRIT COLLECTOR NO 1 DISCHARGE VALVE	21-GRT-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	21-I-001	
24	DO	21PRWZCO1002	OPEN CMD	TRAIN NO 1 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-1002	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	21-I-001	
25	DO	21PRWZCC1002	CLOSE CMD	TRAIN NO 1 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-1002	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	21-I-001	
26	DO	21SCRSRC0001	SPEED RESET CMD	SPEED RESET COMMAND	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RESET CMD	N/A	No	21-I-001	
27	DO	21SCRUCR0001	START TRAIN 1	START TRAIN NO 1 COMMAND	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	START CMD	N/A	No	21-I-001	
28	DO	21SCRUCS0001	STOP TRAIN 1	STOP TRAIN NO 1 COMMAND	21-SCR-LCP-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	STOP CMD	N/A	No	21-I-001	
29	DO	21SCRZCO1001	OPEN CMD	HEADWORKS TRAIN NO 1 INLET VALVE	21-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	21-I-001	
30	DO	21SCRZCC1001	CLOSE CMD	HEADWORKS TRAIN NO 1 INLET VALVE	21-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	21-I-001	
31	DO	21SCRZCO2001	OPEN CMD	HEADWORKS TRAIN NO 2 INLET VALVE	21-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	21-I-001	
32	DO	21SCRZCC2001	CLOSE CMD	HEADWORKS TRAIN NO 2 INLET VALVE	21-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	21-I-001	
33	DI	21GRTYI2001	IN REMOTE	GRIT COLLECTOR NO 2 DISCHARGE VALVE	21-GRT-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	21-I-002	
34	DI	21GRTZIO2001	OPEN	GRIT COLLECTOR NO 2 DISCHARGE VALVE	21-GRT-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	21-I-002	
35	DI	21GRTZIC2001	CLOSED	GRIT COLLECTOR NO 2 DISCHARGE VALVE	21-GRT-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	21-I-002	
36	DI	21PRWYI2002	IN REMOTE	TRAIN NO 2 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-2002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	21-I-002	
37	DI	21PRWZIO2002	OPEN	TRAIN NO 2 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-2002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	21-I-002	
38	DI	21PRWZIC2002	CLOSED	TRAIN NO 2 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-2002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	21-I-002	
39	DI	21SCRYA0002	FAIL	BAR SCREEN NO 2 FAIL	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	FAIL	PLC	No	21-I-002	
40	DI	21SCRYI0002	IN AUTO	BAR SCREEN NO 2 IN AUTO	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN AUTO	PLC	No	21-I-002	
41	DI	21SCRLAH0002	HI LEVEL	BAR SCREEN NO 2 HI LEVEL	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	HI LEVEL	PLC	No	21-I-002	
42	DI	21SCRYA0002	ESTOP	BAR SCREEN NO 2 E-STOP	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	E-STOP	PLC	No	21-I-002	
43	DI	21SCRYIR0002	RUNNING	BAR SCREEN NO 2 RUNNING	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	No	21-I-002	
44	DI	21SCRYIR0002	LOW SPEED	BAR SCREEN NO 2 LOW SPEED	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	LOW SPEED	PLC	No	21-I-002	
45	DI	21SCRYIR0002	HIGH SPEED	BAR SCREEN NO 2 HIGH SPEED	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	HIGH SPEED	PLC	No	21-I-002	
46	DO	21GRTZCO2001	OPEN CMD	GRIT COLLECTOR NO 2 DISCHARGE VALVE	21-GRT-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	21-I-002	

INPUT/OUTPUT LIST - MORRO BAY WRF

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
47	DO	21GRTZCC2001	CLOSE CMD	GRIT COLLECTOR NO 2 DISCHARGE VALVE	21-GRT-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	21-I-002	
48	DO	21PRWZCO2002	OPEN CMD	TRAIN NO 2 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-2002	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	21-I-002	
49	DO	21PRWZCC2002	CLOSE CMD	TRAIN NO 2 GRIT COLLECTOR INLET WASH WATER VALVE	21-PRW-V-2002	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	21-I-002	
50	DO	21SCRSRC0002	SPEED RESET CMD	SPEED RESET COMMAND	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RESET CMD	N/A	No	21-I-002	
51	DO	21SCRUCR0002	START TRAIN 2	START TRAIN NO 2 COMMAND	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	START CMD	N/A	No	21-I-002	
52	DO	21SCRUCS0002	STOP TRAIN 2	STOP TRAIN NO 2 COMMAND	21-SCR-LCP-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	STOP CMD	N/A	No	21-I-002	
53	AI	22SCRFI1001	FLOW	FINE SCREEN NO 1 INLET HEADER FLOW	22-SCR-FIT-1001	21-CTRL-RIO-0001	4-20mA	0-2.00 MGD	4-WIRE	N/A	N/A	N/A	No	22-I-001	
54	AI	22SCRFI2001	FLOW	FINE SCREEN NO 2 INLET HEADER FLOW	22-SCR-FIT-2001	21-CTRL-RIO-0001	4-20mA	0-2.00 MGD	4-WIRE	N/A	N/A	N/A	No	22-I-001	
55	AI	22SCRLI0001	LEVEL	SAFE DIVERSION BOX LEVEL	22-SCR-LIT-0001	21-CTRL-RIO-0001	4-20mA	0-9 FT (EL 127.00-136.00)	4-WIRE	N/A	N/A	N/A	No	22-I-001	
56	AI	22SCRZI1001	POSITION FEEDBACK	FINE SCREEN NO 1 INLET VALVE POSITION	22-SCR-V-1001	21-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	22-I-001	
57	AI	22SCRZI2001	POSITION FEEDBACK	FINE SCREEN NO 2 INLET VALVE POSITION	22-SCR-V-2001	21-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	22-I-001	
58	AO	22SCRFI0010	FLOW	COMPOSITE SAMPLER FLOW COMMAND	22-SCR-SAMP-0001	21-CTRL-RIO-0001	4-20mA		2-WIRE	N/A	N/A	N/A	No	22-I-001	
59	AO	22SCRZC1001	POSITION SETPT	FINE SCREEN NO 1 INLET VALVE POSITION SET PT	22-SCR-V-1001	21-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	22-I-001	
60	AO	22SCRZC2001	POSITION SETPT	FINE SCREEN NO 2 INLET VALVE POSITION SET PT	22-SCR-V-2001	21-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	22-I-001	
61	DI	22SCRYI1104	IN REMOTE	FINE SCREEN NO 1 DISCHARGE VALVE	21-SCR-V-1104	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	22-I-001	
62	DI	22SCRZIO1104	OPEN	FINE SCREEN NO 1 DISCHARGE VALVE	21-SCR-V-1104	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	22-I-001	
63	DI	22SCRZIC1104	CLOSED	FINE SCREEN NO 1 DISCHARGE VALVE	21-SCR-V-1104	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	22-I-001	
64	DI	22SCRYI2003	IN REMOTE	FINE SCREEN NO 2 DISCHARGE VALVE	21-SCR-V-2003	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	22-I-001	
65	DI	22SCRZIO2003	OPEN	FINE SCREEN NO 2 DISCHARGE VALVE	21-SCR-V-2003	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	22-I-001	
66	DI	22SCRZIC2003	CLOSED	FINE SCREEN NO 2 DISCHARGE VALVE	21-SCR-V-2003	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	22-I-001	
67	DI	22SCRYI1001	IN AUTO	FINE SCREEN NO 1 IN AUTO	22-SCR-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN AUTO	PLC	No	22-I-001	
68	DI	22SCRYIR1001	RUNNING FAST	FINE SCREEN NO 1 RUNNING FAST	22-SCR-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING FAST	PLC	No	22-I-001	
69	DI	22SCRYIR1001	RUNNING SLOW	FINE SCREEN NO 1 RUNNING SLOW	22-SCR-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING SLOW	PLC	No	22-I-001	
70	DI	22SCRYA1001	TRBL	FINE SCREEN NO 1 IN TROUBLE	22-SCR-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN TROUBLE	PLC	No	22-I-001	
71	DI	22SCRPDA1001	HI DIFF. PRESSURE	FINE SCREEN NO 1 HIGH DIFFERNTIAL PRESSURE	22-SCR-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI DIFF PRESSURE	PLC	No	22-I-001	
72	DI	22SCRPAL1001	SPRAY WASH LOW PRESSURE	FINE SCREEN NO 1 LOW SPRAY WATER PRESSURE	22-SCR-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LOW PRESSURE	PLC	No	22-I-001	
73	DI	22SCRYI2001	IN AUTO	FINE SCREEN NO 2 IN AUTO	22-SCR-LCP-0002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN AUTO	PLC	No	22-I-001	
74	DI	22SCRYIR2001	RUNNING FAST	FINE SCREEN NO 2 RUNNING FAST	22-SCR-LCP-0002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING FAST	PLC	No	22-I-001	
75	DI	22SCRYIR2001	RUNNING SLOW	FINE SCREEN NO 2 RUNNING SLOW	22-SCR-LCP-0002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING SLOW	PLC	No	22-I-001	
76	DI	22SCRFA2001	TRBL	FINE SCREEN NO 2 IN TROUBLE	22-SCR-LCP-0002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN TROUBLE	PLC	No	22-I-001	
77	DI	22SCRPDA2001	HI DIFF. PRESSURE	FINE SCREEN NO 2 HIGH DIFFERNTIAL PRESSURE	22-SCR-LCP-0002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI DIFF PRESSURE	PLC	No	22-I-001	
78	DI	22SCRPAL2001	SPRAY WASH LOW PRESSURE	FINE SCREEN NO 2 LOW SPRAY WATER PRESSURE	22-SCR-LCP-0002	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LOW PRESSURE	PLC	No	22-I-001	
79	DI	22SCRSI0001	ZERO SPEED	SCREEN CONVEYOR SYSTEM ZERO SPEED	22-SCR-LCP-0003	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	ZERO SPEED	PLC	No	22-I-001	
80	DI	22SCRYA0001	MOTOR OVLD	SCREEN CONVEYOR SYSTEM MOTOR OVERLOAD	22-SCR-LCP-0003	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	MOTOR OVERLOAD	PLC	No	22-I-001	
81	DI	22SCRYIR0001	RUNNING	SCREEN CONVEYOR SYSTEM RUNNING	22-SCR-LCP-0003	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	22-I-001	
82	DI	22SCRYI0001	IN REMOTE	SCREEN CONVEYOR SYSTEM IN REMOTE	22-SCR-LCP-0003	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	22-I-001	
83	DI	22SCRFA0010	TRBL	COMPOSITE SAMPLER IN TROUBLE	22-SCR-SAMP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN TROUBLE	PLC	No	22-I-001	
84	DI	22SCRYI1001	IN REMOTE	FINE SCREEN NO 1 INLET VALVE IN REMOTE	22-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	22-I-001	
85	DI	22SCRZSC2001	CLOSED	FINE SCREEN NO 2 INLET VALVE CLOSED	22-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	22-I-001	
86	DI	22SCRZSO2001	OPEN	FINE SCREEN NO 2 INLET VALVE OPEN	22-SCR-V-1001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	22-I-001	
87	DI	22SCRYI2001	IN REMOTE	FINE SCREEN NO 2 INLET VALVE IN REMOTE	22-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	22-I-001	
88	DI	22SCRZSC2001	CLOSED	FINE SCREEN NO 2 INLET VALVE CLOSED	22-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	22-I-001	
89	DI	22SCRZSO2001	OPEN	FINE SCREEN NO 2 INLET VALVE OPEN	22-SCR-V-2001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	22-I-001	
90	DO	22SCRZCO1104	OPEN CMD	FINE SCREEN NO 1 DISCHARGE VALVE	21-SCR-V-1104	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	22-I-001	
91	DO	22SCRZCC1104	CLOSE CMD	FINE SCREEN NO 1 DISCHARGE VALVE	21-SCR-V-1104	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	22-I-001	
92	DO	22SCRZCO2003	OPEN CMD	FINE SCREEN NO 2 DISCHARGE VALVE	21-SCR-V-2003	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	22-I-001	
93	DO	22SCRZCC2003	CLOSE CMD	FINE SCREEN NO 2 DISCHARGE VALVE	21-SCR-V-2003	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	22-I-001	
94	DO	22SCRUCR1001	RUN CMD	FINE SCREEN NO 1 RUN COMMAND	22-SCR-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	22-I-001	
95	DO	22SCRUCR2001	RUN CMD	FINE SCREEN NO 2 RUN COMMAND	22-SCR-LCP-0002	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	22-I-001	
96	DO	22SCRUCR0001	RUN CMD	SCREEN CONVEYOR SYSTEM RUN COMMAND	22-SCR-LCP-0003	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	22-I-001	
97	AI	23ODCFI0001	FLOW	WATER BOX FLOW	23-ODC-LCP-0001	21-CTRL-RIO-0001	4-20mA	BY ODOR CONTROL MFR	4-WIRE	N/A	N/A	N/A	No	23-I-001	
98	AI	23ODCAI0001	pH	RECIRCULATION PUMP DISCHARGE PH	23-ODC-LCP-0001	21-CTRL-RIO-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	23-I-001	
99	DI	23ODCFAL0001	LOW FLOW	WATER BOX FLOW LOW	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	23-I-001	
100	DI	23ODCPDAH0001	PER FLT. DIFF. PRESSURE	ODOR CONTROL PRE-FILTER DIFFERENTIAL PRESSUREV HIGH	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	COMMON FAIL	PLC	No	23-I-001	
101	DI	23ODCYIR0001	RUNNING	ODOR CONTROL FAN RUNNING	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	23-I-001	
102	DI	23ODCYA0001	FAIL	ODOR CONTROL FAN FAIL	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	23-I-001	
103	DI	23ODCYI0001	IN AUTO	ODOR CONTROL FAN IN AUTO	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN AUTO	PLC	No	23-I-001	
104	DI	23ODCPDAL0001	DIFF. PRESSURE	ODOR CONTROL DIFFERENTIAL PRESSURE LOW	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LOW DIFF PRESSURE	PLC	No	23-I-001	
105	DI	23ODCVAH0001	VIBRATION HIGH	ODOR CONTROL FAN HI VIBRATION	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI VIBRATION	PLC	No	23-I-001	
106	DI	23ODCYIR0001	RUNNING	RECIRCULATION PUMP RUNNING	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	23-I-001	
107	DI	23ODCYA0001	FAIL	RECIRCULATION PUMP FAIL	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	23-I-001	
108	DI	23ODCYI0001	IN AUTO	RECIRCULATION PUMP IN AUTO	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN AUTO	PLC	No	23-I-001	
109	DI	23ODCFAL0001	LOW FLOW	RECIRCULATION PUMP LOW FLOW	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LOW FLOW	PLC	No	23-I-001	
110	DI	23ODCTAL0002	LOW TEMP	OCS STAGE NO 1 HUMIDIFIER LOW TEMP	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LOW TEMP	PLC	No	23-I-001	
111	DI	23ODCTAH0001	HIGH TEMP	OCS STAGE NO 1 HUMIDIFIER HIGH TEMP	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HIGH TEMP	PLC	No	23-I-001	
112	DO	23ODCUCR0001	OCS RUN CMD	ODOR CONTROL SYSTEM RUN COMMAND	23-ODC-LCP-0001	21-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	23-I-001	
113	AI	31AERFI1101	FLOW	BLOWERS TO AERATION BASIN NO 1 DIFFUSERS AIR FLOW	31-AER-FIT-1101	31-CTRL-RIO-0001	4-20mA	BY BLOWER MFR	4-WIRE	N/A	N/A	N/A	No	31-I-001	
114	AI	31AERFI1201	FLOW	BLOWERS TO AERATION BASIN NO 1 DIFFUSERS AIR FLOW	31-AER-FIT-1201	31-CTRL-RIO-0001	4-20mA	BY BLOWER MFR	4-WIRE	N/A	N/A	N/A	No	31-I-001	
115	AI	31AERZI1101	POSITION FEEDBACK	BLOWERS TO AERATION BASIN DIFFUSERS AIR ISO VALVE NO 1 POSITION FEEDB	31-AER-V-1101	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-001	
116	AI	31AERZI1201	POSITION FEEDBACK	BLOWERS TO AERATION BASIN NO 1 DIFFUSERS AIR ISO VALVE NO 2 POSITION F	31-AER-V-1201	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-001	
117	AI	31BNRAI0001	pH	BNR SPLITTER BOX pH LEVEL	31-BNR-AIT-0001	31-CTRL-RIO-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	31-I-001	
118	AI	31BNRAI1001	ORP	BNR ANOXIC AREA OXYGEN REDUCTION POTENTIAL	31-BNR-AIT-1001	31-CTRL-RIO-0001	4-20mA	-1,500-1,500 mV	4-WIRE	N/A	N/A	N/A	No	31-I-001	
119	AI	31BNRAI1002	MLSS	AERATION BASIN NO 1 MLSS CONTENT	31-BNR-AIT-1002	31-CTRL-RIO-0001	4-20mA	0.1-9,999 NTU	4-WIRE	N/A	N/A	N/A	No	31-I-001	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
120	AI	31BNRAI1003	NH3	AERATION BASIN NO 1 AMMONIA (NHNO 3) CONTENT	31-BNR-AIT-1003	31-CTRL-RIO-0001	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	N/A	N/A	N/A	No	31-I-001	
121	AI	31BNRAI1003	NH4	AERATION BASIN NO 1 AMMONIUM (NH4) CONTENT	31-BNR-AIT-1003	31-CTRL-RIO-0001	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	N/A	N/A	N/A	No	31-I-001	
122	AI	31BNRAI1101	DO	BLOWERS TO AERATION BASIN NO 1 DO	31-BNR-AIT-1101	31-CTRL-RIO-0001	4-20mA	0-20 mg/L	4-WIRE	N/A	N/A	N/A	No	31-I-001	
123	AI	31BNRAI1201	DO	AERATION BASIN NO 1 DISSOLVED OXYGEN CONTENT	31-BNR-AIT-1201	31-CTRL-RIO-0001	4-20mA	0-20 mg/L	4-WIRE	N/A	N/A	N/A	No	31-I-001	
124	AI	31MEMLI1001	LEVEL	BASIN NO 1 MIXED LIQUOR COLLECTION CHANNEL LEVEL	31-MEM-LIT-1001	31-CTRL-RIO-0001	4-20mA	0-12.0 FT	4-WIRE	N/A	N/A	N/A	No	31-I-001	
125	AI	31RASAI0001	TSS	RAS DEOX AREA TOTAL SUSPENDED SOLIDS CONTENT	31-RAS-AIT-0001	31-CTRL-RIO-0001	4-20mA	0.1-9,999 NTU	4-WIRE	N/A	N/A	N/A	No	31-I-001	
126	AO	31AERZC1101	POSITION SETPT	BLOWERS TO AERATION BASIN DIFFUSERS AIR ISO VALVE NO 1 POSITION SETPT	31-AER-V-1101	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-001	
127	AO	31AERZC1201	POSITION SETPT	BLOWERS TO AERATION BASIN NO 1 DIFFUSERS AIR ISO VALVE NO 2 POSITION S	31-AER-V-1201	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-001	
128	DI	31AERYI1101	IN REMOTE	BLOWERS TO AERATION BASIN DIFFUSERS AIR ISO VALVE NO 1 IN REMOTE	31-AER-V-1101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-001	
129	DI	31AERZSO1101	OPEN	BLOWERS TO AERATION BASIN DIFFUSERS AIR ISO VALVE NO 1 OPEN	31-AER-V-1101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-001	
130	DI	31AERZSC1101	CLOSE	BLOWERS TO AERATION BASIN DIFFUSERS AIR ISO VALVE NO 1 CLOSE	31-AER-V-1101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-001	
131	DI	31AERYI1201	IN REMOTE	BLOWERS TO AERATION BASIN NO 1 DIFFUSERS AIR ISO VALVE NO 2 IN REMOTE	31-AER-V-1201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-001	
132	DI	31AERZSO1201	OPEN	BLOWERS TO AERATION BASIN NO 1 DIFFUSERS AIR ISO VALVE NO 2 OPEN	31-AER-V-1201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-001	
133	DI	31AERZSC1201	CLOSE	BLOWERS TO AERATION BASIN NO 1 DIFFUSERS AIR ISO VALVE NO 2 CLOSE	31-AER-V-1201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-001	
134	DI	31BNRUA0001	FAIL	BNR SPLITTER BOX pH ANALYZER FAIL	31-BNR-AIT-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
135	DI	31BNRUA1001	FAIL	BNR ANOXIC AREA OXYGEN REDUCTION POTENTIAL ANALYZER FAIL	31-BNR-AIT-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
136	DI	31BNRUA1002	FAIL	AERATION BASIN NO 1 MLSS ANALYZER INSTRUMENT FAIL	31-BNR-AIT-1002	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
137	DI	31BNRUA1003	FAIL	AERATION BASIN NO 1 AMMONIA / AMMONIUM ANALYZER INSTRUMENT FAIL	31-BNR-AIT-1003	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
138	DI	31WASYI1001	IN REMOTE	BASIN NO 1 SCUM COLLECTION BOX TO WAS WETWELL ISO VALVE IN REMOTE	31-WAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-001	
139	DI	31WASZIO1001	OPEN	BASIN NO 1 SCUM COLLECTION BOX TO WAS WETWELL ISO VALVE OPENED	31-WAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-001	
140	DI	31WASZIC1001	CLOSED	BASIN NO 1 SCUM COLLECTION BOX TO WAS WETWELL ISO VALVE CLOSED	31-WAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-001	
141	DI	31BNRUA1101	FAIL	AERATION BASIN DISSOLVED OXYGEN ANALYZER INSTRUMENT FAIL	31-BNR-AIT-1101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
142	DI	31BNRUA1201	FAIL	AERATION BASIN NO 1 DISSOLVED OXYGEN ANALYZER INSTRUMENT FAIL	31-BNR-AIT-1201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
143	DI	31BNRYI1001	IN REMOTE	BASIN NO 1 MBR FEED PUMP DISCHARGE ISO VALVE IN REMOTE	31-BNR-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-001	
144	DI	31BNRZIO1001	OPEN	BASIN NO 1 MBR FEED PUMP DISCHARG ISO VALVE OPENED	31-BNR-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-001	
145	DI	31BNRZIC1001	CLOSED	BASIN NO 1 MBR FEED PUMP DISCHARG ISO VALVE CLOSED	31-BNR-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-001	
146	DI	31RASUA0001	FAIL	RAS DEOX AREA TOTAL SUSPENDED SOLIDS ANALYZER FAIL	31-RAS-AIT-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
147	DO	31WASZCO1001	OPEN CMD	BASIN NO 1 SCUM COLLECTION BOX TO WAS WETWELL ISO VALVE OPEN COMM	31-WAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	31-I-001	
148	DO	31WASZCC1001	CLOSE CMD	BASIN NO 1 SCUM COLLECTION BOX TO WAS WETWELL ISO VALVE CLOSE COMM	31-WAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	31-I-001	
149	DO	31BNRZCO1001	OPEN CMD	BASIN NO 1 MBR FEED PUMP DISCHARG ISO VALVE OPEN COMMAND	31-BNR-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	31-I-001	
150	DO	31BNRZCC1001	CLOSE CMD	BASIN NO 1 MBR FEED PUMP DISCHARG ISO VALVE CLOSE COMMAND	31-BNR-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	No	31-I-001	
151	AI	31BNRSI1001	SPEED FEEDBACK	BASIN NO 1 MBR FEED PUMP SPEED FEEDBACK	31-BNR-P-1001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-001	
152	AO	31BNRSC1001	SPEED SETPT	BASIN NO 1 MBR FEED PUMP SPEED SETPT	31-BNR-P-1001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-001	
153	DI	31BNRUA1001	FAIL	BASIN NO 1 ANOXIC MIXER FAIL	31-BNR-MXR-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
154	DI	31BNRYIR1001	RUNNING	BASIN NO 1 ANOXIC MIXER RUNNING	31-BNR-MXR-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-001	
155	DI	31BNRYI1001	IN REMOTE	BASIN NO 1 ANOXIC MIXER IN REMOTE	31-BNR-MXR-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-001	
156	DI	31BNRYI1001	IN REMOTE	BASIN NO 1 MBR FEED PUMP IN REMOTE	31-BNR-P-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-001	
157	DI	31BNRYIR1001	RUNNING	BASIN NO 1 MBR FEED PUMP RUNNING	31-BNR-P-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-001	
158	DI	31BNRYA1001	FAULT	BASIN NO 1 MBR FEED PUMP FAULT	31-BNR-P-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	31-I-001	
159	DI	31RASUA0001	FAIL	RAS DEOX MIXER FAIL	31-RAS-MXR-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-001	
160	DI	31RASYIR0001	RUNNING	RAS DEOX MIXER RUNNING	31-RAS-MXR-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-001	
161	DI	31RASYI0001	IN REMOTE	RAS DEOX MIXER IN REMOTE	31-RAS-MXR-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-001	
162	DO	31BNRUCR1001	RUN CMD	BASIN NO 1 ANOXIC MIXER RUN COMMAND	31-BNR-MXR-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-001	
163	DO	31BNRUCR1001	RUN CMD	BASIN NO 1 MBR FEED PUMP RUN COMMAND	31-BNR-P-1001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-001	
164	DO	31RASUCR0001	RUN CMD	RAS DEOX MIXER RUN COMMAND	31-RAS-MXR-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-001	
165	AI	31AERFI2101	FLOW	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR FLOW	31-AER-FIT-2101	31-CTRL-RIO-0001	4-20mA	BY BLOWER MFR	4-WIRE	N/A	N/A	N/A	No	31-I-002	
166	AI	31AERFI2201	FLOW	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR FLOW	31-AER-FIT-2201	31-CTRL-RIO-0001	4-20mA	BY BLOWER MFR	4-WIRE	N/A	N/A	N/A	No	31-I-002	
167	AI	31AERZI2101	POSITION FEEDBACK	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 1 POSITION F	31-AER-V-2101	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-002	
168	AI	31AERZI2201	POSITION FEEDBACK	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 2 POSITION F	31-AER-V-2201	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-002	
169	AI	31BNRAI2001	ORP	BASIN NO 2 ANOXIC AREA OXYGEN REDUCTION POTENTIAL	31-BNR-AIT-2001	31-CTRL-RIO-0001	4-20mA	-1,500-1,500 mV	4-WIRE	N/A	N/A	N/A	No	31-I-002	
170	AI	31BNRAI2002	MLSS	AERATION BASIN NO 2 MLSS CONTENT	31-BNR-AIT-2002	31-CTRL-RIO-0001	4-20mA	0.1-9,999 NTU	4-WIRE	N/A	N/A	N/A	No	31-I-002	
171	AI	31BNRAI2003	NH3	AERATION BASIN NO 2 AMMONIA (NHNO 3) CONTENT	31-BNR-AIT-2003	31-CTRL-RIO-0001	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	N/A	N/A	N/A	No	31-I-002	
172	AI	31BNRAI2003	NH4	AERATION BASIN NO 2 AMMONIUM (NH4) CONTENT	31-BNR-AIT-2003	31-CTRL-RIO-0001	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	N/A	N/A	N/A	No	31-I-002	
173	AI	31BNRAI2101	DO	AERATION BASIN NO 2 DISSOLVED OXYGEN CONTENT	31-BNR-AIT-2101	31-CTRL-RIO-0001	4-20mA	0-20 mg/L	4-WIRE	N/A	N/A	N/A	No	31-I-002	
174	AI	31BNRAI2201	DO	AERATION BASIN NO 2 DISSOLVED OXYGEN CONTENT	31-BNR-AIT-2201	31-CTRL-RIO-0001	4-20mA	0-20 mg/L	4-WIRE	N/A	N/A	N/A	No	31-I-002	
175	AI	31MEMLI2001	LEVEL	BASIN NO 2 MIXED LIQUOR COLLECTION CHANNEL LEVEL	31-MEM-LIT-2001	31-CTRL-RIO-0001	4-20mA	0-12.0 FT	4-WIRE	N/A	N/A	N/A	Yes	31-I-002	
176	AO	31AERZC2101	POSITION SETPT	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 1 POSITION S	31-AER-V-2101	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-002	
177	AO	31AERZC2201	POSITION SETPT	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 2 POSITION S	31-AER-V-2201	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-002	
178	DI	31AERYI2101	IN REMOTE	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 1 IN REMOTE	31-AER-V-2101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-002	
179	DI	31AERZSO2101	OPEN	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 1 OPEN	31-AER-V-2101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-002	
180	DI	31AERZSC2101	CLOSE	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 1 CLOSE	31-AER-V-2101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-002	
181	DI	31AERYI2201	IN REMOTE	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 2 IN REMOTE	31-AER-V-2201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-002	
182	DI	31AERZSO2201	OPEN	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 2 OPEN	31-AER-V-2201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-002	
183	DI	31AERZSC2201	CLOSE	BLOWERS TO AERATION BASIN NO 2 DIFFUSERS AIR ISO VALVE NO 2 CLOSE	31-AER-V-2201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-002	
184	DI	31WASYI2001	IN REMOTE	BASIN NO 2 TO WAS DISCAHRGE HEADER ISO VALVE IN REMOTE	31-WAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-002	
185	DI	31WASZIO2001	OPEN	BASIN NO 2 TO WAS DISCAHRGE HEADER ISO VALVE OPENED	31-WAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-002	
186	DI	31WASZIC2001	CLOSED	BASIN NO 2 TO WAS DISCAHRGE HEADER ISO VALVE CLOSED	31-WAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-002	
187	DI	31BNRUA2001	FAIL	BASIN NO 2 ANOXIC AREA ORP ANALYZER INSTRUMENT FAIL	31-BNR-AIT-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-002	
188	DI	31BNRUA2002	FAIL	AERATION BASIN NO 2 MLSS ANALYZER INSTRUMENT FAIL	31-BNR-AIT-2002	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-002	
189	DI	31BNRUA2003	FAIL	AERATION BASIN NO 2 AMMONIA/AMMONIUM ANALYZER INSTRUMENT FAIL	31-BNR-AIT-2003	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-002	
190	DI	31BNRUA2101	FAIL	AERATION BASIN NO 2 DISSOLVED OXYGEN ANALYZER INSTRUMENT FAIL	31-BNR-AIT-2101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-002	
191	DI	31BNRUA2201	FAIL	AERATION BASIN NO 2 DISSOLVED OXYGEN ANALYZER INSTRUMENT FAIL	31-BNR-AIT-2201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-002	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
192	DI	31BNRYI2001	IN REMOTE	BASIN NO 2 MBR FEED PUMP OUTLET VALVE IN REMOTE	31-BNR-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-002	
193	DI	31BNRZIO2001	OPEN	BASIN NO 2 MBR FEED PUMP OUTLET VALVE OPENED	31-BNR-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	31-I-002	
194	DI	31BNRZIC2001	CLOSED	BASIN NO 2 MBR FEED PUMP OUTLET VALVE CLOSED	31-BNR-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	31-I-002	
195	DO	31WASZCO2001	OPEN CMD	BASIN NO 2 TO WAS DISCAHRGE HEADER ISO VALVE OPEN CMD	31-WAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	31-I-002	
196	DO	31WASZCC2001	CLOSE CMD	BASIN NO 2 TO WAS DISCAHRGE HEADER ISO VALVE CLOSE CMD	31-WAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	31-I-002	
197	DO	31BNRZCO2001	OPEN CMD	BASIN NO 2 MBR FEED PUMP OUTLET VALVE OPEN CMD	31-BNR-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	31-I-002	
198	DO	31BNRZCC2001	CLOSE CMD	BASIN NO 2 MBR FEED PUMP OUTLET VALVE CLOSE CMD	31-BNR-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	31-I-002	
199	AI	31BNRSI2001	SPEED FEEDBACK	BASIN NO 2 MBR FEED PUMP SPEED FEEDBACK	31-BNR-P-2001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-002	
200	AO	31BNRSC2001	SPEED SETPT	BASIN NO 2 MBR FEED PUMP SPEED SETPT	31-BNR-P-2001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-002	
201	DI	31BNRUA2001	FAIL	BASIN NO 2 ANOXIC MIXER FAIL	31- BNR-MXR-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	31-I-002	
202	DI	31BNRYIR2001	RUNNING	BASIN NO 2 ANOXIC MIXER RUNNING	31- BNR-MXR-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-002	
203	DI	31BNRYI2001	IN REMOTE	BASIN NO 2 ANOXIC MIXER IN REMOTE	31- BNR-MXR-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-002	
204	DI	31BNRYI2001	IN REMOTE	BASIN NO 2 MBR FEED PUMP IN REMOTE	31-BNR-P-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-002	
205	DI	31BNRYIR2001	RUNNING	BASIN NO 2 MBR FEED PUMP RUNNING	31-BNR-P-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-002	
206	DI	31BNRYA2001	FAULT	BASIN NO 2 MBR FEED PUMP FAULT	31-BNR-P-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	31-I-002	
207	DO	31BNRUCR2001	RUN CMD	BASIN NO 2 ANOXIC MIXER RUN CMD	31-BNR-MXR-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-002	
208	DO	31BNRUCR2001	RUN CMD	BASIN NO 2 MBR FEED PUMP RUN CMD	31-BNR-P-2001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-002	
209	AI	31WASFI0001	FLOW	MBR RAS TO SCUM/WAS PUMPS HEADER FLOW	31-WAS-FIT-0001	31-CTRL-RIO-0001	4-20mA	0-100 GPM	4-WIRE	N/A	N/A	N/A	No	31-I-003	
210	AI	31WASFI0002	FLOW	SCUM/WAS PUMPS OUTLET HEADER FLOW	31-WAS-FIT-0002	31-CTRL-RIO-0001	4-20mA	0-80 GPM	4-WIRE	N/A	N/A	N/A	No	31-I-003	
211	AI	31WASLI0001	LEVEL	SCUM/WAS WETWELL LEVEL	31-WAS-LIT-0001	31-CTRL-RIO-0001	4-20mA	0-9.00 FT (EL 120.5-129.50)	4-WIRE	N/A	N/A	N/A	No	31-I-003	
212	DI	31WASLAHH0001	HI-HI LEVEL	SCUM/WAS WETWELL LEVEL HIGH HIGH	31-WAS-LSHH-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI-HI	PLC	No	31-I-003	
213	DI	31WASLALL0001	LO-LO LEVEL	SCUM/WAS WETWELL LEVEL LOW LOW	31-WAS-LSLL-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LO-LO	PLC	No	31-I-003	
214	DO	31PRWZCO0002	OPEN CMD	PRW SYSTEM ISO VALVE OPEN CMD	31-PRW-V-0002	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	31-I-003	
215	AI	31SCMSI0001	SPEED FEEDBACK	SCUM PUMP SPEED FEEDBACK	31-SCM-P-0001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-003	
216	AI	31WASSI0001	SPEED FEEDBACK	WAS PUMP SPEED FEEDBACK	31-WAS-P-0001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-003	
217	AO	31SCMSC0001	SPEED SETPT	SCUM PUMP SPEED SET PT	31-SCM-P-0001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-003	
218	AO	31WASSC0001	SPEED SETPT	WAS PUMP SPEED SET PT	31-WAS-P-0001	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-003	
219	DI	31SCMYI0001	IN REMOTE	SCUM PUMP IN REMOTE	31-SCM-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-003	
220	DI	31SCMYIR0001	RUNNING	SCUM PUMP RUNNING	31-SCM-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-003	
221	DI	31SCMYA0001	FAULT	SCUM PUMP SPEED FAULT	31-SCM-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	31-I-003	
222	DI	31WASYI0001	IN REMOTE	WAS PUMP SPEED IN REMOTE	31-WAS-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	31-I-003	
223	DI	31WASYIR0001	RUNNING	WAS PUMP SPEED RUNNING	31-WAS-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-003	
224	DI	31WASYA0001	FAULT	WAS PUMP SPEED FAULT	31-WAS-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	31-I-003	
225	DO	31SCMUCR0001	RUN CMD	SCUM PUMP RUN COMMAND	31-SCM-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-003	
226	DO	31WASUCR0001	RUN CMD	WAS PUMP RUN COMMAND	31-WAS-P-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-003	
227	AI	31AERPI0001	PRESSURE	DRY SCREW PROCESS AIR BLOWER DISCAHRGE HEADER PRESSURE	31-AER-PIT-0001	31-CTRL-RIO-0001	4-20mA	0-20 PSI	2-WIRE	N/A	N/A	N/A	No	31-I-004	
228	AI	31AERSI0101	SPEED INDCTN	DRY SCREW PROCESS AIR BLOWER NO 1 SPEED INDICATION	31-AER-BL-0101	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-004	
229	AI	31AERSI0201	SPEED INDCTN	DRY SCREW PROCESS AIR BLOWER NO 2 SPEED INDICATION	31-AER-BL-0201	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-004	
230	AI	31AERSI0301	SPEED INDCTN	DRY SCREW PROCESS AIR BLOWER NO 3 SPEED INDICATION	31-AER-BL-0301	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-004	
231	AO	31AERSC0101	SPEED CONTROL	DRY SCREW PROCESS AIR BLOWER NO 1 SPEED CONTROL	31-AER-BL-0101	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-004	
232	AO	31AERSC0201	SPEED CONTROL	DRY SCREW PROCESS AIR BLOWER NO 2 SPEED CONTROL	31-AER-BL-0201	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-004	
233	AO	31AERSC0301	SPEED CONTROL	DRY SCREW PROCESS AIR BLOWER NO 3 SPEED CONTROL	31-AER-BL-0301	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	31-I-004	
234	DI	31AERYA0101	FAULT	DRY SCREW PROCESS AIR BLOWER NO 1 FAULT	31-AER-BL-0101	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	31-I-004	
235	DI	31AERYIR0101	RUNNING	DRY SCREW PROCESS AIR BLOWER NO 1 RUNNING	31-AER-BL-0101	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-004	
236	DI	31AERYA0201	FAULT	DRY SCREW PROCESS AIR BLOWER NO 2 FAULT	31-AER-BL-0201	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	31-I-004	
237	DI	31AERYIR0201	RUNNING	DRY SCREW PROCESS AIR BLOWER NO 2 RUNNING	31-AER-BL-0201	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-004	
238	DI	31AERYA0301	FAULT	DRY SCREW PROCESS AIR BLOWER NO 3 FAULT	31-AER-BL-0301	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	31-I-004	
239	DI	31AERYIR0301	RUNNING	DRY SCREW PROCESS AIR BLOWER NO 3 RUNNING	31-AER-BL-0301	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	31-I-004	
240	DO	31AERUCR0101	RUN CMD	DRY SCREW PROCESS AIR BLOWER NO 1 RUN CMD	31-AER-BL-0101	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-004	
241	DO	31AERUCR0201	RUN CMD	DRY SCREW PROCESS AIR BLOWER NO 2 RUN CMD	31-AER-BL-0201	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-004	
242	DO	31AERUCR0301	RUN CMD	DRY SCREW PROCESS AIR BLOWER NO 3 RUN CMD	31-AER-BL-0301	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	31-I-004	
243	AI	32RASLI1002	LEVEL	MEMBRANE BASIN NO 1 RAS COLLECTION CHAMBER LEVEL	32-RAS-LIT-1002	31-CTRL-RIO-0001	4-20mA	0-8.5 FT (EL 120.50-129.00	4-WIRE	N/A	N/A	N/A	No	32-I-001	
244	AI	32RASZI2001	POSITION FEEDBACK	MEMBRANE BASIN NO 1 TO RAS DEOX ISOLATION VALVE POSITION FEEDBACK	32-RAS-V-1001	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-001	
245	AI	32RASFI1001	FLOW	MEMBRANE BASIN NO 1 RAS COLLECTION CHANNEL NO 1 TO RAS DEOX FLOW	32-RAS-FIT-1001	31-CTRL-RIO-0001	4-20mA	0-1,200 GPM	4-WIRE	N/A	N/A	N/A	No	32-I-001	
246	AO	32RASZC2001	POSITION SETPT	MEMBRANE BASIN NO 1 TO RAS DEOX ISOLATION VALVE POSITION SET PT	32-RAS-V-1001	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-001	
247	DI	32CAYI1001	IN REMOTE	CITRIC ACID SOLUTION FEED ISOLATION VALVE IN REMOTE	32-CA-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-001	
248	DI	32CAZIO1001	OPEN	CITRIC ACID SOLUTION FEED ISOLATION VALVE OPEN	32-CA-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-001	
249	DI	32CAZIC1001	CLOSED	CITRIC ACID SOLUTION FEED ISOLATION VALVE CLOSED	32-CA-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-001	
250	DI	32NOCLYI1001	IN REMOTE	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE IN REMOTE	32-NOCL-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-001	
251	DI	32NOCLZIO1001	OPEN	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE OPENED	32-NOCL-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-001	
252	DI	32NOCLZIC1001	CLOSED	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE CLOSED	32-NOCL-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-001	
253	DI	32RASYI2001	IN REMOTE	MEMBRANE BASIN NO 1 TO RAS DEOX ISOLATION VALVE IN REMOTE	32-RAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-001	
254	DI	32RASZIO2001	OPEN	MEMBRANE BASIN NO 1 TO RAS DEOX ISOLATION VALVE OPENED	32-RAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-001	
255	DI	32RASZIC2001	CLOSED	MEMBRANE BASIN NO 1 TO RAS DEOX ISOLATION VALVE CLOSED	32-RAS-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-001	
256	DO	32CAZCO1001	OPEN CMD	CITRIC ACID SOLUTION FEED ISOLATION VALVE OPEN CMD	32-CA-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-001	
257	DO	32CAZCC1001	CLOSE CMD	CITRIC ACID SOLUTION FEED ISOLATION VALVE CLOSE CMD	32-CA-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-001	
258	DO	32NOCLZCO1001	OPEN CMD	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE OPEN CMD	32-NOCL-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-001	
259	DO	32NOCLZCC1001	CLOSE CMD	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE CLOSE CMD	32-NOCL-V-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-001	
260	AI	32MEMLI1001	LEVEL	MEMBRANE BASIN NO 1 LEVEL	32-MEM-LIT-1001	32-MBR-PLC-0001	4-20mA	0-12 FT	4-WIRE	N/A	N/A	N/A	No	32-I-001	
261	DI	32AIRZIO1001	OPEN	MEMBRANE BASIN NO 1 BLOWER AIR INLET ISO VALVE OPENED	32-AIR-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-001	
262	DI	32AIRZIC1001	CLOSED	MEMBRANE BASIN NO 1 BLOWER AIR INLET ISO VALVE CLOSED	32-AIR-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-001	
263	DI	32MEMYI1001	IN REMOTE	MEMBRANE BASIN NO 1 ISOLATION VALVE IN REMOTE	32-MEM-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-001	
264	DI	32MEMZIO1001	OPEN	MEMBRANE BASIN NO 1 ISOLATION VALVE OPENED	32-MEM-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-001	
265	DI	32MEMZIC1001	CLOSED	MEMBRANE BASIN NO 1 ISOLATION VALVE CLOSED	32-MEM-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-001	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
266	DI	32MEMZIO1003	OPEN	MEMBRANE BASIN NO 1 EJECTOR ASSEMBLY VALVE OPENED	32-MEM-V-1003	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-001	
267	DI	32MEMZIC1003	CLOSED	MEMBRANE BASIN NO 1 EJECTOR ASSEMBLY VALVE CLOSED	32-MEM-V-1003	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-001	
268	DI	32MEMZIO1006	OPEN	MEMBRANE BASIN NO 1 CIP SOLUTION VALVE OPENED	32-MEM-V-1006	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-001	
269	DI	32MEMZIC1006	CLOSED	MEMBRANE BASIN NO 1 CIP SOLUTION VALVE CLOSED	32-MEM-V-1006	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-001	
270	DI	32MEMLAHH1001	HI-HI LEVEL	MEMBRANE BASIN NO 1 LEVEL HIGH HIGH	32-MEM-LSHH-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	HI-HI	PLC	No	32-I-001	
271	DI	32MEMLALL1001	LO-LO LEVEL	MEMBRANE BASIN NO 1 LEVEL LOW LOW	32-MEM-LSLL-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	LO-LO	PLC	No	32-I-001	
272	DO	32AIRZCO1001	OPEN CMD	MEMBRANE BASIN NO 1 BLOWER AIR INLET ISO VALVE OPEN CMD	32-AIR-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-001	
273	DO	32AIRZCC1001	CLOSE CMD	MEMBRANE BASIN NO 1 BLOWER AIR INLET ISO VALVE CLOSE CMD	32-AIR-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-001	
274	DO	32MEMZCO1001	OPEN CMD	MEMBRANE BASIN NO 1 ISOLATION VALVE OPEN CMD	32-MEM-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-001	
275	DO	32MEMZCC1001	CLOSE CMD	MEMBRANE BASIN NO 1 ISOLATION VALVE CLOSE CMD	32-MEM-V-1001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-001	
276	DO	32IAZCO1002	OPEN CMD	MEMBRANE BASIN NO 1 INSTRUMENT AIR SUPPLY ISO VALVE CLOSE CMD	32-IA-V-1002	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-001	
277	DO	32MEMZCO1003	OPEN CMD	MEMBRANE BASIN NO 1 EJECTOR ASSEMBLY VALVE OPEN CMD	32-MEM-V-1003	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-001	
278	DO	32MEMZCC1003	CLOSE CMD	MEMBRANE BASIN NO 1 EJECTOR ASSEMBLY VALVE CLOSE CMD	32-MEM-V-1003	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-001	
279	AI	32RASLI2002	LEVEL	MEMBRANE BASIN NO 2 RAS COLLECTION CHAMBER LEVEL	32-RAS-LIT-2002	31-CTRL-RIO-0001	4-20mA	0-8.5 FT (EL 120.50-	4-WIRE	N/A	N/A	N/A	No	32-I-002	
280	AI	32RASZI2001	POSITION FEEDBACK	MEMBRANE BASIN NO 2 TO RAS DEOX ISOLATION VALVE POSITION FEEDBACK	32-RAS-V-2001	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-002	
281	AI	32RASFI2001	FLOW	MEMBRANE BASIN NO 2 RAS COLLECTION CHANNEL NO 1 TO RAS DEOX FLOW	32-RAS-FIT-2001	31-CTRL-RIO-0001	4-20mA	0-1,200 GPM	4-WIRE	N/A	N/A	N/A	No	32-I-002	
282	AO	32RASZC2001	POSITION SETPT	MEMBRANE BASIN NO 2 TO RAS DEOX ISOLATION VALVE POSITION SET PT	32-RAS-V-2001	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-002	
283	DI	32CAYI2001	IN REMOTE	CITRIC ACID SOLUTION FEED ISO VALVE IN REMOTE	32-CA-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-002	
284	DI	32CAZIO2001	OPEN	CITRIC ACID SOLUTION FEED ISO VALVE OPENED	32-CA-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-002	
285	DI	32CAZIC2001	CLOSED	CITRIC ACID SOLUTION FEED ISO VALVE CLOSED	32-CA-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-002	
286	DI	32NOCLYI2001	IN REMOTE	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE IN REMOTE	32-NOCL-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-002	
287	DI	32NOCLZIO2001	OPEN	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE OPENED	32-NOCL-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-002	
288	DI	32NOCLZIC2001	CLOSED	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE CLOSED	32-NOCL-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-002	
289	DI	32RASYI2001	IN REMOTE	MEMBRANE BASIN NO 2 TO RAS DEOX ISOLATION VALVE IN REMOTE	32-RAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-002	
290	DI	32RASZIO2001	OPEN	MEMBRANE BASIN NO 2 TO RAS DEOX ISOLATION VALVE OPENED	32-RAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-002	
291	DI	32RASZIC2001	CLOSED	MEMBRANE BASIN NO 2 TO RAS DEOX ISOLATION VALVE CLOSED	32-RAS-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-002	
292	DO	32CAZCO2001	OPEN CMD	CITRIC ACID SOLUTION FEED ISO VALVE OPEN CMD	32-CA-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-002	
293	DO	32CAZCC2001	CLOSE CMD	CITRIC ACID SOLUTION FEED ISO VALVE CLOSE CMD	32-CA-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-002	
294	DO	32NOCLZCO2001	OPEN CMD	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE OPEN CMD	32-NOCL-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-002	
295	DO	32NOCLZCC2001	CLOSE CMD	SODIUM HYPOCHLORITE SOLUTION FEED ISO VALVE CLOSE CMD	32-NOCL-V-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-002	
296	AI	32MEMLI2001	LEVEL	MEMBRANE BASIN NO 2 LEVEL	32-MEM-LIT-2001	32-MBR-PLC-0001	4-20mA	0-12 FT	4-WIRE	N/A	N/A	N/A	No	32-I-002	
297	DI	32AIRZIO2001	OPEN	MEMBRANE BASIN NO 2 BLOWER AIR INLET ISO VALVE OPENED	32-AIR-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-002	
298	DI	32AIRZIC2001	CLOSED	MEMBRANE BASIN NO 2 BLOWER AIR INLET ISO VALVE CLOSED	32-AIR-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-002	
299	DI	32MEMYI2001	IN REMOTE	MEMBRANE BASIN NO 2 INLET ISOLATION VALVE IN REMOTE	32-MEM-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-002	
300	DI	32MEMZIO2001	OPEN	MEMBRANE BASIN NO 2 INLET ISOLATION VALVE OPENED	32-MEM-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-002	
301	DI	32MEMZIC2001	CLOSED	MEMBRANE BASIN NO 2 INLET ISOLATION VALVE CLOSED	32-MEM-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-002	
302	DI	32MEMZIO2003	OPEN	MEMBRANE BASIN NO 2 EJECTOR ASSEMBLY VALVE OPENED	32-MEM-V-2003	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-002	
303	DI	32MEMZIC2003	CLOSED	MEMBRANE BASIN NO 2 EJECTOR ASSEMBLY VALVE CLOSED	32-MEM-V-2003	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-002	
304	DI	32MEMZIC2006	CLOSED	MEMBRANE BASIN NO 2 CIP SOLUTION VALVE OPENED	32-MEM-V-2006	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-002	
305	DI	32MEMZIO2006	OPEN	MEMBRANE BASIN NO 2 CIP SOLUTION VALVE CLOSED	32-MEM-V-2006	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-002	
306	DI	32MEMLAHH2001	HI-HI LEVEL	MEMBRANE BASIN NO 2 LEVEL HIGH HIGH	32-MEM-LSHH-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	HI-HI	PLC	No	32-I-002	
307	DI	32MEMLALL2001	LO-LO LEVEL	MEMBRANE BASIN NO 2 LEVEL LOW LOW	32-MEM-LSLL-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	LO-LO	PLC	No	32-I-002	
308	DO	32AIRZCO2001	OPEN CMD	MEMBRANE BASIN NO 2 BLOWER AIR INLET ISO VALVE OPEN CMD	32-AIR-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-002	
309	DO	32AIRZCC2001	CLOSE CMD	MEMBRANE BASIN NO 2 BLOWER AIR INLET ISO VALVE CLOSE CMD	32-AIR-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-002	
310	DO	32MEMZCO2001	OPEN CMD	MEMBRANE BASIN NO 2 INLET ISOLATION VALVE OPEN CMD	32-MEM-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-002	
311	DO	32MEMZCC2001	CLOSE CMD	MEMBRANE BASIN NO 2 INLET ISOLATION VALVE CLOSE CMD	32-MEM-V-2001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-002	
312	DO	32IAZCO2002	OPEN CMD	MEMBRANE BASIN NO 2 INSTRUMENT AIR SUPPLY ISOLATION VALVE OPEN CMD	32-IA-V-2002	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-002	
313	DO	32MEMZCO2003	OPEN CMD	MEMBRANE BASIN NO 2 EJECTOR ASSEMBLY VALVE OPEN CMD	32-MEM-V-2003	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-002	
314	DO	32MEMZCC2003	CLOSE CMD	MEMBRANE BASIN NO 2 EJECTOR ASSEMBLY VALVE CLOSE CMD	32-MEM-V-2003	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	32-I-002	
315	DI	32MEMYA1001	FAIL	FILTRATE PUMP NO 1 OUTLET TURBIDITY ANALYZER FAIL	32-MEM-AIT-1001	31-CTRL-RIO-0001	N/A	N/A	N/A	MODBUS	FAIL	MODBUS	No	32-I-003	
316	DI	32MEMYIR0001	RUNNING	FILTRATE PUMP NO 1 OUTLET TURBIDITY SAMPLE PUMP RUNNING	32-MEM-P-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-003	
317	DI	32MEMUA0001	FAIL	FILTRATE PUMP NO 1 OUTLET TURBIDITY SAMPLE PUMP FAIL	32-MEM-P-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-003	
318	DO	32MEMUCR0001	RUN CMD	FILTRATE PUMP NO 1 OUTLET TURBIDITY SAMPLE PUMP RUN CMD	32-MEM-P-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-003	
319	AI	32MEMAI1001	TURB	FILTRATE PUMP NO 1 OUTLET TURBIDITY MEASUREMENT	32-MEM-AIT-1001	32-MBR-PLC-0001	4-20mA	0-10 NTU	4-WIRE	N/A	N/A	N/A	No	32-I-003	
320	AI	32MEMFI1001	FLOW	FILTRATE PUMP NO 1 OUTLET FLOW	32-MEM-FIT-1001	32-MBR-PLC-0001	4-20mA	0-1,200 GPM	4-WIRE	N/A	N/A	N/A	No	32-I-003	
321	AI	32MEMSI1001	SPEED FEEDBACK	FILTRATE PUMP NO 1 SPEED FEEDBACK	32-MEM-P-1001	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-003	
322	AI	32MEMPI1001	PRESSURE	MEMBRANE BASIN NO 1 FILTRATE PRESSURE	32-MEM-PIT-1001	32-MBR-PLC-0001	4-20mA	-15-15 PSIG	2-WIRE	N/A	N/A	N/A	Yes	32-I-003	
323	AI	32MEMZI1005	POSITION FEEDBACK	FILTRATE PUMP NO 1 INLET ISO VALVE POSITION FEEDBACK	32-MEM-V-1005	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	Yes	32-I-003	
324	AO	32MEMSC1001	SPEED SETPT	FILTRATE PUMP NO 1 SPEED SETPT	32-MEM-P-1001	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-003	
325	AO	32MEMZC1005	POSITION SETPT	FILTRATE PUMP NO 1 INLET ISO VALVE POSITION SET PT	32-MEM-V-1005	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-003	
326	DI	32MEMYI1001	IN REMOTE	FILTRATE PUMP NO 1 IN REMOTE	32-MEM-P-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	Yes	32-I-003	
327	DI	32MEMYIR1001	RUNNING	FILTRATE PUMP NO 1 RUNNING	32-MEM-P-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-003	
328	DI	32MEMYA1001	AFD FAULT	FILTRATE PUMP NO 1 AFD FAULT	32-MEM-P-1001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	32-I-003	
329	DI	32MEMZIO1005	OPEN	FILTRATE PUMP NO 1 INLET ISO VALVE OPEN	32-MEM-V-1005	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-003	
330	DI	32MEMZIC1005	CLOSED	FILTRATE PUMP NO 1 INLET ISO VALVE CLOSED	32-MEM-V-1005	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-003	
331	DO	32MEMUCR1001	REV CMD	FILTRATE PUMP NO 1 REVERSE CMD	32-MEM-P-1001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	REV CMD	FIELD	Yes	32-I-003	
332	DO	32MEMUCR1001	FWD CMD	FILTRATE PUMP NO 1 FORWARD CMD	32-MEM-P-1001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	FWD CMD	FIELD	Yes	32-I-003	
333	DO	32MEMZCO1014	OPEN CMD	FILTRATE PUMP NO 1 OUTLET TURBIDITY INSTRUMENT ISO VALVE OPEN CMD	32-MEM-V-1014	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-003	
334	DI	32MEMYA2001	FAIL	FILTRATE PUMP NO 2 OUTLET TURBIDITY ANALYZER FAIL	32-MEM-AIT-2001	31-CTRL-RIO-0001	N/A	N/A	N/A	MODBUS	FAIL	MODBUS	No	32-I-004	
335	DI	32MEMYIR0002	RUNNING	FILTRATE PUMP NO 2 OUTLET TURBIDITY SAMPLE PUMP RUNNING	32-MEM-P-0002	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-004	
336	DI	32MEMUA0002	FAIL	FILTRATE PUMP NO 2 OUTLET TURBIDITY SAMPLE PUMP FAIL	32-MEM-P-0002	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-004	
337	DO	32MEMUCR0002	RUN CMD	FILTRATE PUMP NO 2 OUTLET TURBIDITY SAMPLE PUMP RUN CMD	32-MEM-P-0002	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-004	
338	AI	32MEMAI2001	TURB	FILTRATE PUMP NO 2 OUTLET TURBIDITY MEASUREMENT	32-MEM-AIT-2001	32-MBR-PLC-0001	4-20mA	0-10 NTU	4-WIRE	N/A	N/A	N/A	No	32-I-004	
339	AI	32MEMFI2001	FLOW	FILTRATE PUMP NO 2 OUTLET FLOW	32-MEM-FIT-2001	32-MBR-PLC-0001	4-20mA	0-1,200 GPM	4-WIRE	N/A	N/A	N/A	No	32-I-004	
340	AI	32MEMSI2001	SPEED FEEDBACK	FILTRATE PUMP NO 2 SPEED FEEDBACK	32-MEM-P-2001	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-004	
341	AI	32MEMPI1001	PRESSURE	MEMBRANE BASIN NO 2 FILTRATE PRESSURE	32-MEM-PIT-2001	32-MBR-PLC-0001	4-20mA	-15-15 PSIG	2-WIRE	N/A	N/A	N/A	No	32-I-004	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
342	AI	32MEMZI2005	POSITION FEEDBACK	FILTRATE PUMP NO 2 INLET ISO VALVE POSITION FEEDBACK	32-MEM-V-2006	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-004	
343	AO	32MEMSC2001	SPEED SETPT	FILTRATE PUMP NO 2 SPEED SETPT	32-MEM-P-2001	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-004	
344	AO	32MEMZC2005	POSITION SETPT	FILTRATE PUMP NO 2 INLET ISO VALVE POSITION SET PT	32-MEM-V-2006	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-004	
345	DI	32MEMYI2001	IN REMOTE	FILTRATE PUMP NO 2 IN REMOTE	32-MEM-P-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-004	
346	DI	32MEMYIR2001	RUNNING	FILTRATE PUMP NO 2 RUNNING	32-MEM-P-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-004	
347	DI	32MEMYA2001	AFD FAULT	FILTRATE PUMP NO 2 AFD FAULT	32-MEM-P-2001	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	32-I-004	
348	DI	32MEMZIO2005	OPEN	FILTRATE PUMP NO 2 INLET ISO VALVE OPEN	32-MEM-V-2006	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	32-I-004	
349	DI	32MEMZIC2005	CLOSED	FILTRATE PUMP NO 2 INLET ISO VALVE CLOSED	32-MEM-V-2006	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	32-I-004	
350	DO	32MEMUCR2001	REV CMD	FILTRATE PUMP NO 2 REVERSE CMD	32-MEM-P-2001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	REV CMD	FIELD	Yes	32-I-004	
351	DO	32MEMUCR2001	FWD CMD	FILTRATE PUMP NO 2 FORWARD CMD	32-MEM-P-2001	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	FWD CMD	FIELD	Yes	32-I-004	
352	DO	32MEMZCO2014	OPEN CMD	FILTRATE PUMP NO 2 OUTLET TURBIDITY INSTRUMENT ISO VALVE OPEN CMD	32-MEM-V-2014	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-004	
353	DI	32MEMUA0002	FAIL	RO FEED TANK INLET HEADER TURBIDITY ANALYZER INSTRUMENT FAIL	32-MEM-AIT-0002	31-CTRL-RIO-0001	N/A	N/A	N/A	MODBUS	FAIL	MODBUS	No	32-I-005	
354	DI	32MEMYIR0003	RUNNING	FILTRATE MANIFOLD TURBIDITY SAMPLE PUMP RUNNING	32-MEM-P-0003	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-005	
355	DI	32MEMUA0003	FAIL	FILTRATE MANIFOLD TURBIDITY SAMPLE PUMP FAIL	32-MEM-P-0003	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-005	
356	AI	32MEMAI0002	TURB	RO FEED TANK INLET HEADER TURBIDITY MEASUREMENT	32-MEM-AIT-0002	32-MBR-PLC-0001	4-20mA	0-10 NTU	4-WIRE	N/A	N/A	N/A	No	32-I-005	
357	AI	32MEMTI0001	TEMP	RO FEED TANK INLET HEADER TEMPERATURE MEASUREMENT	32-MEM-TIT-0001	32-MBR-PLC-0001	4-20mA	32-104 DEG F	2-WIRE	N/A	N/A	N/A	No	32-I-005	
358	AI	32AIRSI0101	SPEED INDCTN	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 1 SPEED INDICATION	32-AIR-BL-0101	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-006	
359	AI	32AIRSI0201	SPEED INDCTN	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 2 SPEED INDICATION	32-AIR-BL-0201	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-006	
360	AO	32AIRSC0101	SPEED CONTROL	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 1 SPEED CONTROL	32-AIR-BL-0101	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-006	
361	AO	32AIRSC0201	SPEED CONTROL	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 2 SPEED CONTROL	32-AIR-BL-0201	32-MBR-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-006	
362	DI	32AIRYA0101	FAULT	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 1 FAULT	32-AIR-BL-0101	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	32-I-006	
363	DI	32AIRYIR0101	RUNNING	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 1 RUNNING	32-AIR-BL-0101	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-006	
364	DI	32AIRYA0201	FAULT	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 2 FAULT	32-AIR-BL-0201	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	32-I-006	
365	DI	32AIRYIR0201	RUNNING	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 2 RUNNING	32-AIR-BL-0201	32-MBR-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-006	
366	DO	32AIRUCR0101	RUN CMD	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 1 RUN CMD	32-AIR-BL-0101	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-006	
367	DO	32AIRUCR0201	RUN CMD	ROTARY LOBE MEMBRANE SCOUR BLOWER NO 2 RUN CMD	32-AIR-BL-0201	32-MBR-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-006	
368	AI	32DRNFI0001	FLOW	DRAIN PUMP OUTLET FLOW	32-DRN-FIT-0001	32-MBR-LCP-0001	4-20mA	0-750 GPM	4-WIRE	N/A	N/A	N/A	No	32-I-007	
369	AI	32DRNSI0001	SPEED FEEDBACK	DRAIN PUMP SPEED FEEDBACK	32-DRN-P-0001	32-MBR-LCP-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-007	
370	AO	32DRNSC0001	SPEED SETPT	DRAIN PUMP SPEED SETPT	32-DRN-P-0001	32-MBR-LCP-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	32-I-007	
371	DI	32DRNYI0001	IN REMOTE	DRAIN PUMP IN REMOTE	32-DRN-P-0001	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-007	
372	DI	32DRNYIR0001	RUNNING	DRAIN PUMP RUNNING	32-DRN-P-0001	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-007	
373	DI	32DRNYA0001	FAIL	DRAIN PUMP FAIL	32-DRN-P-0001	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-007	
374	DO	32DRNUCR0001	RUN CMD	DRAIN PUMP RUN CMD	32-DRN-P-0001	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-007	
375	DO	32AIRZCO0001	OPEN CMD	DRAIN PUMP OPEN CMD	32-DRN-V-0001	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-007	
376	DO	32AIRZCO0002	OPEN CMD	DRAIN PUMP OPEN CMD	32-DRN-V-0002	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-007	
377	DI	32AIRUA1001	FAIL	AIR DRYER NO 1 FAIL	32-AIR-AD-1001	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-008	
378	DI	32AIRUA1002	FAIL	AIR DRYER NO 2 FAIL	32-AIR-AD-1002	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-008	
379	DI	32AIRUA1001	FAIL	AIR COMPRESSOR NO 1 FAIL	32-AIR-CMP-1001	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-008	
380	DI	32AIRYIR1001	RUNNING	AIR COMPRESSOR NO 1 RUNNING	32-AIR-CMP-1001	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-008	
381	DI	32AIRYI1001	IN REMOTE	AIR COMPRESSOR NO 1 IN REMOTE	32-AIR-CMP-1001	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-008	
382	DI	32AIRUA1002	FAIL	AIR COMPRESSOR NO 2 FAIL	32-AIR-CMP-1002	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	32-I-008	
383	DI	32AIRYIR1002	RUNNING	AIR COMPRESSOR NO 2 RUNNING	32-AIR-CMP-1002	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	32-I-008	
384	DI	32AIRYI1002	IN REMOTE	AIR COMPRESSOR NO 2 IN REMOTE	32-AIR-CMP-1002	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	32-I-008	
385	DI	32AIRPAL1002	LO PRESSURE	AIR RECEIVER TANK DISCHARGE HEADER LOW PRESSURE	32-AIR-PSL-1002	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	PRESSURE LOW	PLC	No	32-I-008	
386	DI	32AIRPALL1003	LO-LO PRESSURE	AIR RECEIVER TANK DISCHARGE HEADER LOW LOW PRESSURE	32-AIR-PSLL-1003	32-MBR-LCP-0001	N/A	N/A	N/A	24VDC	LOW LOW PRESSURE	PLC	No	32-I-008	
387	DO	32AIRUCR1001	RUN CMD	AIR DRYER NO 1 RUN COMMAND	32-AIR-AD-1001	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-008	
388	DO	32AIRUCR1002	RUN CMD	AIR DRYER NO 2 RUN COMMAND	32-AIR-AD-1002	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-008	
389	DO	32AIRUCR1001	RUN CMD	AIR COMPRESSOR NO 1 RUN COMMAND	32-AIR-CMP-1001	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-008	
390	DO	32AIRUCR1002	RUN CMD	AIR COMPRESSOR NO 2 RUN COMMAND	32-AIR-CMP-1002	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	32-I-008	
391	DO	32AIRZCO0018	OPEN CMD	DISCHARGE AIR HEADER DRAIN VALVE OPEN CMD	32-AIR-V-0018	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-008	
392	DO	32AIRZCO0019	OPEN CMD	AIR RECEIVER TANK DRAIN VALVE OPEN CMD	32-AIR-V-0019	32-MBR-LCP-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	32-I-008	
393	AI	33ROAI0001	NH3	RO FEED TANK INLET HEADER NHNO 3 MEASUREMENT	32-MEM-AIT-0001	31-CTRL-RIO-0001	4-20mA	0-2 ppm (as N) 0.1-	4-WIRE	N/A	N/A	N/A	No	33-I-001	
394	AI	33ROLI0101	LEVEL	RO FEED TANK NO 1 LEVEL	33-RO-LIT-0101	31-CTRL-RIO-0001	4-20mA	120.5-141.50)	2-WIRE	N/A	N/A	N/A	No	33-I-001	
395	AI	33ROLI0201	LEVEL	RO FEED TANK NO 2 LEVEL	33-RO-LIT-0201	31-CTRL-RIO-0001	4-20mA	120.5-141.50)	2-WIRE	N/A	N/A	N/A	No	33-I-001	
396	DI	33ROUA0001	FAIL	RO FEED TANK INLET HEADER NHNO 3 ANALYZER INSTRUMENT FAIL	32-MEM-AIT-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	33-I-001	
397	DI	33ROLAHH0101	HI-HI LEVEL	RO FEED TANK NO 1 LEVEL HIGH HIGH	33-RO-LSHH-0101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI-HI	PLC	No	33-I-001	
398	DI	33ROLAHH0201	HI-HI LEVEL	RO FEED TANK NO 2 LEVEL HIGH HIGH	33-RO-LSHH-0201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI-HI	PLC	No	33-I-001	
399	DI	33ROLALL0101	LO-LO LEVEL	RO FEED TANK NO 1 LEVEL LOW LOW	33-RO-LSLL-0101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LO-LO	PLC	No	33-I-001	
400	DI	33ROLALL0201	LO-LO LEVEL	RO FEED TANK NO 2 LEVEL LOW LOW	33-RO-LSLL-0201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LO-LO	PLC	No	33-I-001	
401	AI	34PRWSI0101	SPEED FEEDBACK	RECYCLED WATER PUMP NO 1 SPEED FEEDBACK	34-PRW-P-0101	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	34-I-001	
402	AI	34PRWSI0201	SPEED FEEDBACK	RECYCLED WATER PUMP NO 2 SPEED FEEDBACK	34-PRW-P-0201	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	34-I-001	
403	AI	34PRWSI0301	SPEED FEEDBACK	RECYCLED WATER PUMP NO 3 SPEED FEEDBACK	34-PRW-P-0301	31-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	34-I-001	
404	AI	34PRWPI0001	PRESSURE	RECYCLED WATER PUMP HEADER DISCHARGE PRESSURE	34-PRW-PIT-0001	31-CTRL-RIO-0001	4-20mA	0-100 PSI	2-WIRE	N/A	N/A	N/A	No	34-I-001	
405	AI	34PRWFI0001	FLOW	RECYCLED WATER PUMP HEADER DISCHARGE FLOW	34-PRW-FIT-0001	31-CTRL-RIO-0001	4-20mA	0-150 GPM	4-WIRE	N/A	N/A	N/A	No	34-I-001	
406	DI	34PRWYIR0101	RUNNING	RECYCLED WATER PUMP NO 1 RUNNING	34-PRW-P-0101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	34-I-001	
407	DI	34PRWUA0101	FAIL	RECYCLED WATER PUMP NO 1 FAIL	34-PRW-P-0101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	34-I-001	
408	DI	34PRWYIR0201	RUNNING	RECYCLED WATER PUMP NO 2 RUNNING	34-PRW-P-0201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	34-I-001	
409	DI	34PRWUA0201	FAIL	RECYCLED WATER PUMP NO 2 FAIL	34-PRW-P-0201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	34-I-001	
410	DI	34PRWYIR0301	RUNNING	RECYCLED WATER PUMP NO 3 RUNNING	34-PRW-P-0301	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	34-I-001	
411	DI	34PRWUA0301	FAIL	RECYCLED WATER PUMP NO 3 FAIL	34-PRW-P-0301	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	34-I-001	
412	DI	34PRWPAH0101	HI PRESSURE	RECYCLED WATER PUMP NO 1 DISCHARGE PRESSURE HIGH	34-PRW-PSH-0101	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	34-I-001	
413	DI	34PRWPAH0201	HI PRESSURE	RECYCLED WATER PUMP NO 2 DISCHARGE PRESSURE HIGH	34-PRW-PSH-0201	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	34-I-001	
414	DI	34PRWPAH0301	HI PRESSURE	RECYCLED WATER PUMP NO 3 DISCHARGE PRESSURE HIGH	34-PRW-PSH-0301	31-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	34-I-001	
415	DO	34PRWUCA0001	BACKUP EMERGENCY POWER	BACKUP EMERGENCY POWER RUN CMD	34-PRW-LCP-0001	31-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	34-I-001	
416	AI	51ROAI0001	COND	RO FEED PUMPS COMMON HEADER INLET CONDUCTIVITY	51-RO-AIT-0001	51-CTRL-RIO-0001	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-001	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
417	AI	51ROAI0002	TURB	RO FEED PUMPS COMMON HEADER INLET TURBIDITY	51-RO-AIT-0002	51-CTRL-RIO-0001	4-20mA	0-40 NTU	4-WIRE	N/A	N/A	N/A	No	51-I-001	
418	AI	51ROAI0003	ORP	RO FEED PUMPS COMMON HEADER INLET ORP	51-RO-AIT-0003	51-CTRL-RIO-0001	4-20mA	-1,500-1,500 mV	4-WIRE	N/A	N/A	N/A	No	51-I-001	
419	AI	51ROAI0004	FREE CL2	RO FEED PUMPS COMMON HEADER INLET FREE CHLORINE	51-RO-AIT-0004	51-CTRL-RIO-0001	4-20mA	0-10 mg/L	4-WIRE	N/A	N/A	N/A	No	51-I-001	
420	AI	51ROAI0005	NH3	RO FEED PUMPS COMMON HEADER INLET MONO-CHLORIMINE/AMMONIA	51-RO-AIT-0005	51-CTRL-RIO-0001	4-20mA	0-2 ppm (as N) 0.1-10.0 mg/L (as Cl2)	4-WIRE	N/A	N/A	N/A	No	51-I-001	
421	AI	51ROAI0006	pH	RO FEED PUMPS COMMON HEADER INLET pH	51-RO-AIT-0006	51-CTRL-RIO-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	51-I-001	
422	AI	51ROAI0006	TEMP	RO FEED PUMPS COMMON HEADER INLET TEMP	51-RO-AIT-0006	51-CTRL-RIO-0001	4-20mA		4-WIRE	N/A	N/A	N/A	No	51-I-001	
423	AI	51ROFI0001	FLOW	RO FEED PUMPS COMMON HEADER INLET FLOW	51-RO-FIT-0001	51-CTRL-RIO-0001	4-20mA	0-1.30 MGD	4-WIRE	N/A	N/A	N/A	No	51-I-001	
424	DI	51ROFA0001	COND FAULT	RO FEED PUMPS COMMON HEADER INLET CONDUCTIVITY ANALYZER INSTRUME	51-RO-AIT-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	51-I-001	
425	DI	51ROFA0002	TURB FAULT	RO FEED PUMPS COMMON HEADER INLET TURBIDITY ANALYZER INSTRUMENT F	51-RO-AIT-0002	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	51-I-001	
426	DI	51ROFA0003	ORP FAULT	RO FEED PUMPS COMMON HEADER INLET ORP ANALYZER INSTRUMENT FAIL	51-RO-AIT-0003	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	51-I-001	
427	DI	51ROFA0004	CL2 FAULT	RO FEED PUMPS COMMON HEADER INLET FREE CHLORINE ANALYZER INSTRUM	51-RO-AIT-0004	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	51-I-001	
428	DI	51ROFA0005	NH3 FAULT	RO FEED PUMPS COMMON HEADER INLET MONO-CHLORIMINE/AMMONIA ANA	51-RO-AIT-0005	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	51-I-001	
429	DI	51ROFA0006	pH FAULT	RO FEED PUMPS COMMON HEADER INLET pH/TEMP ANALYZER INSTRUMENT FA	51-RO-AIT-0006	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAULT	PLC	No	51-I-001	
430	DI	51ROFAL0001	FLOW LOW	RO FEED ANALYZER PANEL INLET SAMPLE FLOW LOW	51-RO-FSL-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LOW FLOW	PLC	No	51-I-001	
431	DI	51ROYIR0001	RUNNING	RO INLET SAMPLE PUMP RUNNING	51-RO-P-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-001	
432	DI	51ROUA0001	FAIL	RO INLET SAMPLE PUMP FAIL	51-RO-P-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-001	
433	DI	51ROYI0012	IN REMOTE	RO PUMP TO OCEAN OUTFALL TANK ISO VALVE IN REMOTE	51-RO-V-0012	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-001	
434	DI	51ROZIO0012	OPEN	RO PUMP TO OCEAN OUTFALL TANK ISO VALVE OPENED	51-RO-V-0012	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-001	
435	DI	51ROZIC0012	CLOSED	RO PUMP TO OCEAN OUTFALL TANK ISO VALVE CLOSED	51-RO-V-0012	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-001	
436	DO	51ROUCR0001	RUN CMD	RO INLET SAMPLE PUMP RUN COMMAND	51-RO-P-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-001	
437	DO	51ROZCO0012	OPEN CMD	RO PUMP TO OCEAN OUTFALL TANK ISO VALVE OPEN CMD	51-RO-V-0012	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-001	
438	DO	51ROZCC0012	CLOSE CMD	RO PUMP TO OCEAN OUTFALL TANK ISO VALVE CLOSE CMD	51-RO-V-0012	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-001	
439	AI	51RODPI0103	DIFF. PRESSURE	RO CARTRIDGE FILTER NO 1 DIFF. PRESSURE	51-RO-PDIT-0103	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-002	
440	AI	51ROSI0101	SPEED FEEDBACK	RO PUMP NO 1 SPEED FEEDBACK	51-RO-VFD-0101	51-RO-RIO-0101	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-002	
441	AO	51ROSC0101	SPEED SETPT	RO PUMP NO 1 SPEED SETPOINT	51-RO-VFD-0101	51-RO-RIO-0101	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-002	
442	DI	51ROYI0107	IN REMOTE	RO FLUSH PUMPS TO RO SYSTEM NO 1 FLUSH VALVE IN REMOTE	51-RO-V-0107	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-002	
443	DI	51ROZIO0107	OPEN	RO FLUSH PUMPS TO RO SYSTEM NO 1 FLUSH VALVE OPENED	51-RO-V-0107	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-002	
444	DI	51ROZIC0107	CLOSED	RO FLUSH PUMPS TO RO SYSTEM NO 1 FLUSH VALVE CLOSED	51-RO-V-0107	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-002	
445	DI	51ROPAL0101	LO PRESSURE	RO PUMP NO 1 SUCTION PRESSURE LOW	51-RO-VFD-0101	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	PRESSURE LOW	PLC	No	51-I-002	
446	DI	51ROPAH0101	HI PRESSURE	RO PUMP NO 1 DISCHARGE PRESSURE HIGH	51-RO-VFD-0101	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	51-I-002	
447	DI	51ROYI0101	IN REMOTE	RO PUMP NO 1 IN REMOTE	51-RO-VFD-0101	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-002	
448	DI	51ROYIR0101	RUNNING	RO PUMP NO 1 RUNNING	51-RO-VFD-0101	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-002	
449	DI	51ROUA0101	FAIL	RO PUMP NO 1 FAILED	51-RO-VFD-0101	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-002	
450	DO	51ROZCO0107	OPEN CMD	RO FLUSH PUMPS TO RO SYSTEM NO 1 FLUSH VALVE OPEN CMD	51-RO-V-0107	51-RO-RIO-0101	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-002	
451	DO	51ROZCC0107	CLOSE CMD	RO FLUSH PUMPS TO RO SYSTEM NO 1 FLUSH VALVE CLOSE CMD	51-RO-V-0107	51-RO-RIO-0101	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-002	
452	DO	51ROUCR0101	RUN CMD	RO PUMP NO 1 RUN CMD	51-RO-VFD-0101	51-RO-RIO-0101	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-002	
453	DO	51ROUC0101	RESET CMD	RO PUMP NO 1 RESET CMD	51-RO-VFD-0101	51-RO-RIO-0101	N/A	N/A	N/A	N/A	RESET CMD	FIELD	Yes	51-I-002	
454	AI	51RODPI0203	DIFF. PRESSURE	RO CARTRIDGE FILTER NO 2 DIFF. PRESSURE	51-RO-PDIT-0203	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-002	
455	AI	51ROSI0201	SPEED FEEDBACK	RO PUMP NO 2 SPEED FEEDBACK	51-RO-VFD-0201	51-RO-RIO-0201	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-002	
456	AO	51ROSC0201	SPEED SETPT	RO PUMP NO 2 SPEED SETPOINT	51-RO-VFD-0201	51-RO-RIO-0201	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-002	
457	DI	51ROYI0207	IN REMOTE	RO FLUSH PUMPS TO RO SYSTEM NO 2 FLUSH VALVE IN REMOTE	51-RO-V-0207	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-002	
458	DI	51ROZIO0207	OPEN	RO FLUSH PUMPS TO RO SYSTEM NO 2 FLUSH VALVE OPENED	51-RO-V-0207	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-002	
459	DI	51ROZIC0207	CLOSED	RO FLUSH PUMPS TO RO SYSTEM NO 2 FLUSH VALVE CLOSED	51-RO-V-0207	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-002	
460	DI	51ROPAL0201	LO PRESSURE	RO PUMP NO 2 SUCTION PRESSURE LOW	51-RO-VFD-0201	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	PRESSURE LOW	PLC	No	51-I-002	
461	DI	51ROPAH0201	HI PRESSURE	RO PUMP NO 2 DISCHARGE PRESSURE HIGH	51-RO-VFD-0201	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	51-I-002	
462	DI	51ROYI0201	IN REMOTE	RO PUMP NO 2 IN REMOTE	51-RO-VFD-0201	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-002	
463	DI	51ROYIR0201	RUNNING	RO PUMP NO 2 RUNNING	51-RO-VFD-0201	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-002	
464	DI	51ROUA0201	FAIL	RO PUMP NO 2 FAILED	51-RO-VFD-0201	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-002	
465	DO	51ROZCO0207	OPEN CMD	RO FLUSH PUMPS TO RO SYSTEM NO 2 FLUSH VALVE OPEN CMD	51-RO-V-0207	51-RO-RIO-0201	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-002	
466	DO	51ROZCC0207	CLOSE CMD	RO FLUSH PUMPS TO RO SYSTEM NO 2 FLUSH VALVE CLOSE CMD	51-RO-V-0207	51-RO-RIO-0201	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-002	
467	DO	51ROUCR0201	RUN CMD	RO PUMP NO 2 RUN CMD	51-RO-VFD-0201	51-RO-RIO-0201	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-002	
468	DO	51ROUC0201	RESET CMD	RO PUMP NO 2 RESET CMD	51-RO-VFD-0201	51-RO-RIO-0201	N/A	N/A	N/A	N/A	RESET CMD	FIELD	Yes	51-I-002	
469	AI	51RODPI0303	DIFF. PRESSURE	RO CARTRIDGE FILTER NO 3 DIFF. PRESSURE	51-RO-PDIT-0303	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-002	
470	AI	51ROSI0301	SPEED FEEDBACK	RO PUMP NO 3 SPEED FEEDBACK	51-RO-VFD-0301	51-RO-RIO-0301	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-002	
471	AO	51ROSC0301	SPEED SETPT	RO PUMP NO 3 SPEED SETPOINT	51-RO-VFD-0301	51-RO-RIO-0301	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-002	
472	DI	51ROYI0307	IN REMOTE	RO FLUSH PUMPS TO RO SYSTEM NO 3 FLUSH VALVE IN REMOTE	51-RO-V-0307	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-002	
473	DI	51ROZIO0307	OPEN	RO FLUSH PUMPS TO RO SYSTEM NO 3 FLUSH VALVE OPENED	51-RO-V-0307	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-002	
474	DI	51ROZIC0307	CLOSED	RO FLUSH PUMPS TO RO SYSTEM NO 3 FLUSH VALVE CLOSED	51-RO-V-0307	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-002	
475	DI	51ROPAL0301	LO PRESSURE	RO PUMP NO 3 SUCTION PRESSURE LOW	51-RO-VFD-0301	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	PRESSURE LOW	PLC	No	51-I-002	
476	DI	51ROPAH0301	HI PRESSURE	RO PUMP NO 3 DISCHARGE PRESSURE HIGH	51-RO-VFD-0301	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	51-I-002	
477	DI	51ROYI0301	IN REMOTE	RO PUMP NO 3 IN REMOTE	51-RO-VFD-0301	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-002	
478	DI	51ROYIR0301	RUNNING	RO PUMP NO 3 RUNNING	51-RO-VFD-0301	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-002	
479	DI	51ROUA0301	FAIL	RO PUMP NO 3 FAILED	51-RO-VFD-0301	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-002	
480	DO	51ROZCO0307	OPEN CMD	RO FLUSH PUMPS TO RO SYSTEM NO 3 FLUSH VALVE OPEN CMD	51-RO-V-0307	51-RO-RIO-0301	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-002	
481	DO	51ROZCC0307	CLOSE CMD	RO FLUSH PUMPS TO RO SYSTEM NO 3 FLUSH VALVE CLOSE CMD	51-RO-V-0307	51-RO-RIO-0301	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-002	
482	DO	51ROUCR0301	RUN CMD	RO PUMP NO 3 RUN CMD	51-RO-VFD-0301	51-RO-RIO-0301	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-002	
483	DO	51ROUC0301	RESET CMD	RO PUMP NO 3 RESET CMD	51-RO-VFD-0301	51-RO-RIO-0301	N/A	N/A	N/A	N/A	RESET CMD	FIELD	Yes	51-I-002	
484	AI	51ROAI1001	COND	RO UNIT NO 1 STAGE NO 1 PERMEATE CONDUCTIVITY	51-RO-AIT-1001	51-RO-RIO-0101	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-003	
485	AI	51ROAI1002	COND	RO UNIT NO 1 STAGE NO 2 PERMEATE CONDUCTIVITY	51-RO-AIT-1002	51-RO-RIO-0101	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-003	
486	AI	51ROFI1001	FLOW	RO UNIT NO 1 STAGE NO 2 PERMEATE FLOW	51-RO-FIT-1001	51-RO-RIO-0101	4-20mA	0-1.30 MGD	4-WIRE	N/A	N/A	N/A	No	51-I-003	
487	AI	51ROPI1001	PRESSURE	RO UNIT NO 1 STAGE NO 1 INLET PRESSURE	51-RO-PIT-1001	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-003	
488	AI	51ROPI1002	PRESSURE	RO UNIT NO 1 STAGE NO 1 PERMEATE PRESSURE	51-RO-PIT-1002	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-003	
489	AI	51ROPI1003	PRESSURE	RO UNIT NO 1 STAGE NO 1 CONCENTRATE PRESSURE	51-RO-PIT-1003	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-003	
490	AI	51ROPI1004	PRESSURE	RO UNIT NO 1 STAGE NO 2 INLET PRESSURE	51-RO-PIT-1004	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-003	
491	AI	51ROPI1005	PRESSURE	RO UNIT NO 1 STAGE NO 2 CONCENTRATE PRESSURE	51-RO-PIT-1005	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-003	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
492	AI	51ROSI1001	SPEED FEEDBACK	RO UNIT NO 1 BOOSTER PUMP SPEED	51-RO-VFD-1001	51-RO-RIO-0101	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-003	
493	AO	51ROSC1001	SPEED SETPT	RO UNIT NO 1 BOOSTER PUMP SPEED SETPT	51-RO-VFD-1001	51-RO-RIO-0101	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-003	
494	DI	51ROYA1001	FAIL	RO UNIT NO 1 STAGE NO 1 PERMEATE CONDUCTIVITY ANALYZER INSTRUMENT F	51-RO-AIT-1001	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-003	
495	DI	51ROUA1002	FAIL	RO UNIT NO 1 STAGE NO 2 PERMEATE CONDUCTIVITY ANALYZER INSTRUMENT F	51-RO-AIT-1002	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-003	
496	DI	51ROYI1001	IN REMOTE	RO UNIT NO 1 INLET VALVE IN REMOTE	51-RO-V-1001	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-003	
497	DI	51ROZIO1001	OPEN	RO UNIT NO 1 INLET VALVE OPENED	51-RO-V-1001	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-003	
498	DI	51ROZIC1001	CLOSED	RO UNIT NO 1 INLET VALVE CLOSED	51-RO-V-1001	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-003	
499	DI	51ROYI1001	IN REMOTE	RO UNIT NO 1 BOOSTER PUMP IN REMOTE	51-RO-VFD-1001	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-003	
500	DI	51ROYIR1001	RUNNING	RO UNIT NO 1 BOOSTER PUMP RUNNING	51-RO-VFD-1001	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-003	
501	DI	51ROYA1001	FAIL	RO UNIT NO 1 BOOSTER PUMP FAILED	51-RO-VFD-1001	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-003	
502	DO	51ROZCO1001	OPEN CMD	RO UNIT NO 1 INLET VALVE OPEN CMD	51-RO-V-1001	51-RO-RIO-0101	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-003	
503	DO	51ROZCC1001	CLOSE CMD	RO UNIT NO 1 INLET VALVE CLOSE CMD	51-RO-V-1001	51-RO-RIO-0101	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-003	
504	DO	51ROUCR1001	RUN CMD	RO UNIT NO 1 BOOSTER PUMP RUN CMD	51-RO-VFD-1001	51-RO-RIO-0101	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-003	
505	DO	51ROUC1001	RESET CMD	RO UNIT NO 1 BOOSTER PUMP RESET CMD	51-RO-VFD-1001	51-RO-RIO-0101	N/A	N/A	N/A	N/A	RESET CMD	FIELD	Yes	51-I-003	
506	AI	51ROAI2001	COND	RO UNIT NO 2 STAGE NO 1 PERMEATE CONDUCTIVITY	51-RO-AE-2001	51-RO-RIO-0201	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-004	
507	AI	51ROAI2002	COND	RO UNIT NO 2 STAGE NO 2 PERMEATE CONDUCTIVITY	51-RO-AIT-2002	51-RO-RIO-0201	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-004	
508	AI	51ROFI2001	FLOW	RO UNIT NO 2 STAGE NO 2 PERMEATE FLOW	51-RO-FIT-2001	51-RO-RIO-0201	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-004	
509	AI	51ROPI2001	PRESSURE	RO UNIT NO 2 STAGE NO 1 INLET PRESSURE	51-RO-PIT-2001	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-004	
510	AI	51ROPI2002	PRESSURE	RO UNIT NO 2 STAGE NO 1 PERMEATE PRESSURE	51-RO-PIT-2002	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-004	
511	AI	51ROPI2003	PRESSURE	RO UNIT NO 2 STAGE NO 1 CONCENTRATE PRESSURE	51-RO-PIT-2003	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-004	
512	AI	51ROPI2004	PRESSURE	RO UNIT NO 2 STAGE NO 2 INLET PRESSURE	51-RO-PIT-2004	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-004	
513	AI	51ROPI2005	PRESSURE	RO UNIT NO 2 STAGE NO 2 CONCENTRATE PRESSURE	51-RO-PIT-2005	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-004	
514	AI	51ROSI2001	SPEED FEEDBACK	RO UNIT NO 2 BOOSTER PUMP SPEED	51-RO-VFD-2001	51-RO-RIO-0201	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-004	
515	AO	51ROSC2001	SPEED SETPT	RO UNIT NO 2 BOOSTER PUMP SPEED SETPT	51-RO-VFD-2001	51-RO-RIO-0201	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-004	
516	DI	51ROYA2001	FAIL	RO UNIT NO 2 STAGE NO 1 PERMEATE CONDUCTIVITY ANALYZER INSTRUMENT F	51-RO-AIT-2001	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-004	
517	DI	51ROYA2002	FAIL	RO UNIT NO 2 STAGE NO 2 PERMEATE CONDUCTIVITY ANALYZER INSTRUMENT F	51-RO-AIT-2002	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-004	
518	DI	51ROYI2001	IN REMOTE	RO UNIT NO 2 INLET VALVE IN REMOTE	51-RO-V-2001	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-004	
519	DI	51ROZIO2001	OPEN	RO UNIT NO 2 INLET VALVE OPENED	51-RO-V-2001	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-004	
520	DI	51ROZIC2001	CLOSED	RO UNIT NO 2 INLET VALVE CLOSED	51-RO-V-2001	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-004	
521	DI	51ROYI2001	IN REMOTE	RO UNIT NO 2 BOOSTER PUMP IN REMOTE	51-RO-VFD-2001	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-004	
522	DI	51ROYIR2001	RUNNING	RO UNIT NO 2 BOOSTER PUMP RUNNING	51-RO-VFD-2001	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-004	
523	DI	51ROYA2001	FAIL	RO UNIT NO 2 BOOSTER PUMP FAILED	51-RO-VFD-2001	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-004	
524	DO	51ROZCO2001	OPEN CMD	RO UNIT NO 2 INLET VALVE OPEN CMD	51-RO-V-2001	51-RO-RIO-0201	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-004	
525	DO	51ROZCC2001	CLOSE CMD	RO UNIT NO 2 INLET VALVE CLOSE CMD	51-RO-V-2001	51-RO-RIO-0201	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-004	
526	DO	51ROUCR2001	RUN CMD	RO UNIT NO 2 BOOSTER PUMP RUN CMD	51-RO-VFD-2001	51-RO-RIO-0201	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-004	
527	DO	51ROUC2001	RESET CMD	RO UNIT NO 2 BOOSTER PUMP RESET CMD	51-RO-VFD-2001	51-RO-RIO-0201	N/A	N/A	N/A	N/A	RESET CMD	FIELD	Yes	51-I-004	
528	AI	51ROAI3001	COND	RO UNIT NO 3 STAGE NO 1 PERMEATE CONDUCTIVITY	51-RO-AIT-3001	51-RO-RIO-0301	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-005	
529	AI	51ROAI3002	COND	RO UNIT NO 3 STAGE NO 2 PERMEATE CONDUCTIVITY	51-RO-AIT-3002	51-RO-RIO-0301	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-005	
530	AI	51ROFI3001	FLOW	RO UNIT NO 3 STAGE NO 2 PERMEATE FLOW	51-RO-FIT-3001	51-RO-RIO-0301	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-005	
531	AI	51ROPI3001	PRESSURE	RO UNIT NO 3 STAGE NO 1 INLET PRESSURE	51-RO-PIT-3001	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-005	
532	AI	51ROPI3002	PRESSURE	RO UNIT NO 3 STAGE NO 1 PERMEATE PRESSURE	51-RO-PIT-3002	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-005	
533	AI	51ROPI3003	PRESSURE	RO UNIT NO 3 STAGE NO 1 CONCENTRATE PRESSURE	51-RO-PIT-3003	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-005	
534	AI	51ROPI3004	PRESSURE	RO UNIT NO 3 STAGE NO 2 INLET PRESSURE	51-RO-PIT-3004	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-005	
535	AI	51ROPI3005	PRESSURE	RO UNIT NO 3 STAGE NO 2 CONCENTRATE PRESSURE	51-RO-PIT-3005	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-005	
536	AI	51ROSI3001	SPEED FEEDBACK	RO UNIT NO 3 BOOSTER PUMP SPEED	51-RO-VFD-3001	51-RO-RIO-0301	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-005	
537	AO	51ROSC3001	SPEED SETPT	RO UNIT NO 3 BOOSTER PUMP SPEED SETPT	51-RO-VFD-3001	51-RO-RIO-0301	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-005	
538	DI	51ROYA3001	FAIL	RO UNIT NO 3 STAGE NO 1 PERMEATE CONDUCTIVITY ANALYZER INSTRUMENT F	51-RO-AIT-3001	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-005	
539	DI	51ROYA3002	FAIL	RO UNIT NO 3 STAGE NO 2 PERMEATE CONDUCTIVITY ANALYZER INSTRUMENT F	51-RO-AIT-3002	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-005	
540	DI	51ROYI3001	IN REMOTE	RO UNIT NO 3 INLET VALVE IN REMOTE	51-RO-V-3001	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-005	
541	DI	51ROZIO3001	OPEN	RO UNIT NO 3 INLET VALVE OPENED	51-RO-V-3001	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-005	
542	DI	51ROZIC3001	CLOSED	RO UNIT NO 3 INLET VALVE CLOSED	51-RO-V-3001	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-005	
543	DI	51ROYI3001	IN REMOTE	RO UNIT NO 3 BOOSTER PUMP IN REMOTE	51-RO-VFD-3001	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-005	
544	DI	51ROYIR3001	RUNNING	RO UNIT NO 3 BOOSTER PUMP RUNNING	51-RO-VFD-3001	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-005	
545	DI	51ROYA3001	FAIL	RO UNIT NO 3 BOOSTER PUMP FAILED	51-RO-VFD-3001	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-005	
546	DO	51ROZCO3001	OPEN CMD	RO UNIT NO 3 INLET VALVE OPEN CMD	51-RO-V-3001	51-RO-RIO-0301	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-005	
547	DO	51ROZCC3001	CLOSE CMD	RO UNIT NO 3 INLET VALVE CLOSE CMD	51-RO-V-3001	51-RO-RIO-0301	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-005	
548	DO	51ROUCR3001	RUN CMD	RO UNIT NO 3 BOOSTER PUMP RUN CMD	51-RO-VFD-3001	51-RO-RIO-0301	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-005	
549	DO	51ROUC3001	RESET CMD	RO UNIT NO 3 BOOSTER PUMP RESET CMD	51-RO-VFD-3001	51-RO-RIO-0301	N/A	N/A	N/A	N/A	RESET CMD	FIELD	Yes	51-I-005	
550	AI	51ROAI1003	COND	PERMATE FROM RO UNIT NO 1 VESSELS CONDUCTIVITY	51-RO-AIT-1003	51-RO-RIO-0101	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-006	
551	AI	51ROAI1004	COND	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM CONDUCTIVI	51-RO-AIT-1004	51-RO-RIO-0101	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-006	
552	AI	51ROFI1002	FLOW	PERMATE FLOW FROM RO UNIT NO 1 VESSELS	51-RO-FIT-1002	51-RO-RIO-0101	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-006	
553	AI	51ROFI1003	FLOW	CONCENTRATE FLOW FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM	51-RO-FIT-1003	51-RO-RIO-0101	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-006	
554	AI	51ROPI1006	PRESSURE	PERMATE PRESSURE FROM RO UNIT NO 1 VESSELS	51-RO-PIT-1006	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-006	
555	AI	51ROPI1007	PRESSURE	CONCENTRATE PRESSURE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM	51-RO-PIT-1007	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-006	
556	AI	51ROPI1008	PRESSURE	CONCENTRATE PRESSURE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM	51-RO-PIT-1008	51-RO-RIO-0101	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-006	
557	AI	51ROZI1047	POSITION FEEDBACK	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-1047	51-RO-RIO-0101	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-006	
558	AO	51ROZC1047	POSITION SETPT	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-1047	51-RO-RIO-0101	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-006	
559	DI	51ROYA1003	FAIL	PERMATE FROM RO UNIT NO 1 VESSELS CONDUCTIVITY INSTRUMENT FAIL	51-RO-AIT-1003	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-006	
560	DI	51ROYA1004	FAIL	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM CONDUCTIVI	51-RO-AIT-1004	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-006	
561	DI	51ROPAH1006	HI PRESSURE	PERMATE PRESSURE FROM RO UNIT NO 1 VESSELS HIGH	51-RO-PSH-1006	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	51-I-006	
562	DI	51ROYI1040	IN REMOTE	PERMATE FROM RO UNIT NO 1 VESSELS TO OUTFALL BALANCING TANK VALVE I	51-RO-V-1040	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-006	
563	DI	51ROZIO1040	OPEN	PERMATE FROM RO UNIT NO 1 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-1040	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-006	
564	DI	51ROZIC1040	CLOSED	PERMATE FROM RO UNIT NO 1 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-1040	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-006	
565	DI	51ROYI1042	IN REMOTE	PERMATE FROM RO UNIT NO 1 VESSELS TO UV SYSTEM VALVE IN REMOTE	51-RO-V-1042	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-006	
566	DI	51ROZIO1042	OPEN	PERMATE FROM RO UNIT NO 1 VESSELS TO UV SYSTEM VALVE OPENED	51-RO-V-1042	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-006	
567	DI	51ROZIC1042	CLOSED	PERMATE FROM RO UNIT NO 1 VESSELS TO UV SYSTEM VALVE CLOSED	51-RO-V-1042	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-006	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
568	DI	51ROYI1047	IN REMOTE	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-1047	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-006	
569	DI	51ROZIO1047	OPEN	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-1047	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-006	
570	DI	51ROZIC1047	CLOSED	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-1047	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-006	
571	DI	51ROYI1048	IN REMOTE	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-1048	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-006	
572	DI	51ROZIO1048	OPEN	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-1048	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-006	
573	DI	51ROZIC1048	CLOSED	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-1048	51-RO-RIO-0101	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-006	
574	DO	51ROZCO1040	OPEN CMD	PERMATE FROM RO UNIT NO 1 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-1040	51-RO-RIO-0101	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-006	
575	DO	51ROZCC1040	CLOSE CMD	PERMATE FROM RO UNIT NO 1 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-1040	51-RO-RIO-0101	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-006	
576	DO	51ROZCO1042	OPEN CMD	PERMATE FROM RO UNIT NO 1 VESSELS TO UV SYSTEM VALVE OPEN CMD	51-RO-V-1042	51-RO-RIO-0101	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-006	
577	DO	51ROZCC1042	CLOSE CMD	PERMATE FROM RO UNIT NO 1 VESSELS TO UV SYSTEM VALVE CLOSE CMD	51-RO-V-1042	51-RO-RIO-0101	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-006	
578	DO	51ROZCO1048	OPEN CMD	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-1048	51-RO-RIO-0101	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-006	
579	DO	51ROZCC1048	CLOSE CMD	CONCENTRATE FROM RO UNIT NO 1 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-1048	51-RO-RIO-0101	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-006	
580	AI	51ROAI2003	COND	PERMATE FROM RO UNIT NO 2 VESSELS CONDUCTIVITY	51-RO-AIT-2003	51-RO-RIO-0201	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-007	
581	AI	51ROAI2004	COND	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM CONDUCTIVI	51-RO-AIT-2004	51-RO-RIO-0201	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-007	
582	AI	51ROFI2002	FLOW	PERMATE FLOW FROM RO UNIT NO 2 VESSELS	51-RO-FIT-2002	51-RO-RIO-0201	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-007	
583	AI	51ROFI2003	FLOW	CONCENTRATE FLOW FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM	51-RO-FIT-2003	51-RO-RIO-0201	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-007	
584	AI	51ROPI2006	PRESSURE	PERMATE PRESSURE FROM RO UNIT NO 2 VESSELS	51-RO-PIT-2006	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-007	
585	AI	51ROPI2007	PRESSURE	CONCENTRATE PRESSURE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM	51-RO-PIT-2007	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-007	
586	AI	51ROPI2008	PRESSURE	CONCENTRATE PRESSURE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM	51-RO-PIT-2008	51-RO-RIO-0201	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-007	
587	AI	51ROZI2047	POSITION FEEDBACK	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-2047	51-RO-RIO-0201	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-007	
588	AO	51ROZC2047	POSITION SETPT	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-2047	51-RO-RIO-0201	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-007	
589	DI	51ROYA2003	FAIL	PERMATE FROM RO UNIT NO 2 VESSELS CONDUCTIVITY INSTRUMENT FAIL	51-RO-AIT-2003	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-007	
590	DI	51ROYA2004	FAIL	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM CONDUCTIVI	51-RO-AIT-2004	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-007	
591	DI	51ROPAH2006	HI PRESSURE	PERMATE PRESSURE FROM RO UNIT NO 2 VESSELS HIGH	51-RO-PSH-2006	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	51-I-007	
592	DI	51ROYI2040	IN REMOTE	PERMATE FROM RO UNIT NO 2 VESSELS TO OUTFALL BALANCING TANK VALVE I	51-RO-V-2040	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-007	
593	DI	51ROZIO2040	OPEN	PERMATE FROM RO UNIT NO 2 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-2040	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-007	
594	DI	51ROZIC2040	CLOSED	PERMATE FROM RO UNIT NO 2 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-2040	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-007	
595	DI	51ROYI2042	IN REMOTE	PERMATE FROM RO UNIT NO 2 VESSELS TO UV SYSTEM VALVE IN REMOTE	51-RO-V-2042	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-007	
596	DI	51ROZIO2042	OPEN	PERMATE FROM RO UNIT NO 2 VESSELS TO UV SYSTEM VALVE OPENED	51-RO-V-2042	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-007	
597	DI	51ROZIC2042	CLOSED	PERMATE FROM RO UNIT NO 2 VESSELS TO UV SYSTEM VALVE CLOSED	51-RO-V-2042	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-007	
598	DI	51ROYI2047	IN REMOTE	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-2047	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-007	
599	DI	51ROZIO2047	OPEN	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-2047	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-007	
600	DI	51ROZIC2047	CLOSED	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-2047	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-007	
601	DI	51ROYI2048	IN REMOTE	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-2048	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-007	
602	DI	51ROZIO2048	OPEN	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-2048	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-007	
603	DI	51ROZIC2048	CLOSED	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-2048	51-RO-RIO-0201	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-007	
604	DO	51ROZCO2040	OPEN CMD	PERMATE FROM RO UNIT NO 2 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-2040	51-RO-RIO-0201	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-007	
605	DO	51ROZCC2040	CLOSE CMD	PERMATE FROM RO UNIT NO 2 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-2040	51-RO-RIO-0201	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-007	
606	DO	51ROZCO2042	OPEN CMD	PERMATE FROM RO UNIT NO 2 VESSELS TO UV SYSTEM VALVE OPEN CMD	51-RO-V-2042	51-RO-RIO-0201	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-007	
607	DO	51ROZCC2042	CLOSE CMD	PERMATE FROM RO UNIT NO 2 VESSELS TO UV SYSTEM VALVE CLOSE CMD	51-RO-V-2042	51-RO-RIO-0201	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-007	
608	DO	51ROZCO2048	OPEN CMD	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-2048	51-RO-RIO-0201	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-007	
609	DO	51ROZCC2048	CLOSE CMD	CONCENTRATE FROM RO UNIT NO 2 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-2048	51-RO-RIO-0201	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-007	
610	AI	51ROAI3003	COND	PERMATE FROM RO UNIT NO 3 VESSELS CONDUCTIVITY	51-RO-AIT-3003	51-RO-RIO-0301	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-008	
611	AI	51ROAI3004	COND	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM CONDUCTIVI	51-RO-AIT-3004	51-RO-RIO-0301	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	51-I-008	
612	AI	51ROFI3002	FLOW	PERMATE FLOW FROM RO UNIT NO 3 VESSELS	51-RO-FIT-3002	51-RO-RIO-0301	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-008	
613	AI	51ROFI3003	FLOW	CONCENTRATE FLOW FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM	51-RO-FIT-3003	51-RO-RIO-0301	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-008	
614	AI	51ROPI3006	PRESSURE	PERMATE PRESSURE FROM RO UNIT NO 3 VESSELS	51-RO-PIT-3006	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-008	
615	AI	51ROPI3007	PRESSURE	CONCENTRATE PRESSURE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM	51-RO-PIT-3007	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-008	
616	AI	51ROPI3008	PRESSURE	CONCENTRATE PRESSURE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM	51-RO-PIT-3008	51-RO-RIO-0301	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-008	
617	AI	51ROZI3047	POSITION FEEDBACK	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-3047	51-RO-RIO-0301	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-008	
618	AO	51ROZC3047	POSITION SETPT	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-3047	51-RO-RIO-0301	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-008	
619	DI	51ROYA3003	FAIL	PERMATE FROM RO UNIT NO 3 VESSELS CONDUCTIVITY INSTRUMENT FAIL	51-RO-AIT-3003	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-008	
620	DI	51ROYA3004	FAIL	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM CONDUCTIVI	51-RO-AIT-3004	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-008	
621	DI	51ROPAH3006	HI PRESSURE	PERMATE PRESSURE FROM RO UNIT NO 3 VESSELS HIGH	51-RO-PSH-3006	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	51-I-008	
622	DI	51ROYI3040	IN REMOTE	PERMATE FROM RO UNIT NO 3 VESSELS TO OUTFALL BALANCING TANK VALVE I	51-RO-V-3040	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-008	
623	DI	51ROZIO3040	OPEN	PERMATE FROM RO UNIT NO 3 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-3040	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-008	
624	DI	51ROZIC3040	CLOSED	PERMATE FROM RO UNIT NO 3 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-3040	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-008	
625	DI	51ROYI3042	IN REMOTE	PERMATE FROM RO UNIT NO 3 VESSELS TO UV SYSTEM VALVE IN REMOTE	51-RO-V-3042	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-008	
626	DI	51ROZIO3042	OPEN	PERMATE FROM RO UNIT NO 3 VESSELS TO UV SYSTEM VALVE OPENED	51-RO-V-3042	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-008	
627	DI	51ROZIC3042	CLOSED	PERMATE FROM RO UNIT NO 3 VESSELS TO UV SYSTEM VALVE CLOSED	51-RO-V-3042	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-008	
628	DI	51ROYI3047	IN REMOTE	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-3047	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-008	
629	DI	51ROZIO3047	OPEN	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-3047	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-008	
630	DI	51ROZIC3047	CLOSED	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM MAIN VALVE	51-RO-V-3047	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-008	
631	DI	51ROYI3048	IN REMOTE	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-3048	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-008	
632	DI	51ROZIO3048	OPEN	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-3048	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-008	
633	DI	51ROZIC3048	CLOSED	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-3048	51-RO-RIO-0301	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-008	
634	DO	51ROZCO3040	OPEN CMD	PERMATE FROM RO UNIT NO 3 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-3040	51-RO-RIO-0301	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-008	
635	DO	51ROZCC3040	CLOSE CMD	PERMATE FROM RO UNIT NO 3 VESSELS TO OUTFALL BALANCING TANK VALVE C	51-RO-V-3040	51-RO-RIO-0301	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-008	
636	DO	51ROZCO3042	OPEN CMD	PERMATE FROM RO UNIT NO 3 VESSELS TO UV SYSTEM VALVE OPEN CMD	51-RO-V-3042	51-RO-RIO-0301	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-008	
637	DO	51ROZCC3042	CLOSE CMD	PERMATE FROM RO UNIT NO 3 VESSELS TO UV SYSTEM VALVE CLOSE CMD	51-RO-V-3042	51-RO-RIO-0301	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-008	
638	DO	51ROZCO3048	OPEN CMD	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-3048	51-RO-RIO-0301	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-008	
639	DO	51ROZCC3048	CLOSE CMD	CONCENTRATE FROM RO UNIT NO 3 VESSELS TO OUTFALL SYSTEM BYPASS VALV	51-RO-V-3048	51-RO-RIO-0301	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-008	
640	DI	51CIPLAH0001	HI LEVEL	CIP AREA BUND LEVEL HIGH	51-CIP-LSH-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEVEL HIGH	PLC	No	51-I-009	
641	DI	51ROFAH0001	EYEWASH FLOW	RO AREA EYEWASH FLOW DETECTED	51-RO-FSH-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FLOW HIGH	PLC	No	51-I-009	
642	AI	51CIPAI0201	pH	NEUTRALIZATION TANK CIP-T-0201 pH	51-CIP-AIT-0201	51-RO-PLC-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	51-I-009	
643	AI	51CIPTI0001	TEMP	RO CIP PUMP STATION DISCHARGE HEADER EDUCTOR TEMPERATURE	51-CIP-EDC-0001	51-RO-PLC-0001	4-20mA	BY RO MFR	2-WIRE	N/A	N/A	N/A	No	51-I-009	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
644	AI	51CIPFI0101	FLOW	RO PERMEATE (MAKEUP) FLOW TO CIP MAKEUP TANK CIP-T-0101	51-CIP-FIT-0101	51-RO-PLC-0001	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-009	
645	AI	51CIPLI0101	LEVEL	CIP MAKEUP TANK CIP-T-0101 LEVEL	51-CIP-LIT-0101	51-RO-PLC-0001	4-20mA	0-5.0 FT	4-WIRE	N/A	N/A	N/A	No	51-I-009	
646	AI	51CIPLI0201	LEVEL	CIP MAKEUP TANK CIP-T-0201 LEVEL	51-CIP-LIT-0201	51-RO-PLC-0001	4-20mA	0-5.0 FT	4-WIRE	N/A	N/A	N/A	No	51-I-009	
647	DI	51CIPYA0201	FAIL	NEUTRALIZATION TANK CIP-T-0201 pH INSTRUMENT FAIL	51-CIP-AIT-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-009	
648	DI	51CIPYI0001	IN REMOTE	RO CIP PUMP STATION DISCHARGE HEADER EDUCTOR IN REMOTE	51-CIP-EDC-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-009	
649	DI	51CIPYIR0001	RUNNING	RO CIP PUMP STATION DISCHARGE HEADER EDUCTOR RUNNING	51-CIP-EDC-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-009	
650	DI	51CIPYA0001	FAIL	RO CIP PUMP STATION DISCHARGE HEADER EDUCTOR FAIL	51-CIP-EDC-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-009	
651	DI	51CIPLAH0101	HI LEVEL	CIP MAKEUP TANK CIP-T-0101 LEVEL HIGH	51-CIP-LSH-0101	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	LEVEL HIGH	PLC	No	51-I-009	
652	DI	51CIPLAH0201	HI LEVEL	NEUTRALIZATION TANK CIP-T-0201 LEVEL HIGH	51-CIP-LSH-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	LEVEL HIGH	PLC	No	51-I-009	
653	DI	51CIPLAL0101	LO LEVEL	CIP MAKEUP TANK CIP-T-0101 LEVEL LOW	51-CIP-LSL-0101	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	LEVEL LOW	PLC	No	51-I-009	
654	DI	51CIPLAL0201	LO LEVEL	NEUTRALIZATION TANK CIP-T-0201 LEVEL LOW	51-CIP-LSL-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	LEVEL LOW	PLC	No	51-I-009	
655	DI	51CIPYI0001	IN REMOTE	NEUTRALIZATION TANK CIP-T-0201 MIXER IN REMOTE	51-CIP-MXR-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-009	
656	DI	51CIPYIR0001	RUNNING	NEUTRALIZATION TANK CIP-T-0201 MIXER IN RUNNING	51-CIP-MXR-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-009	
657	DI	51CIPYA0001	FAIL	NEUTRALIZATION TANK CIP-T-0201 MIXER IN FAIL	51-CIP-MXR-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAILED	PLC	No	51-I-009	
658	DI	51CIPZIO0103	OPEN	RO PERMEATE (MAKEUP) TO CIP MAKEUP TANK CIP-T-0101 VALVE OPENED	51-CIP-V-0103	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	Yes	51-I-009	
659	DI	51CIPZIC0103	CLOSED	RO PERMEATE (MAKEUP) TO CIP MAKEUP TANK CIP-T-0101 VALVE CLOSED	51-CIP-V-0103	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-009	
660	DI	51CIPYI0103	IN REMOTE	RO PERMEATE (MAKEUP) TO CIP MAKEUP TANK CIP-T-0101 VALVE IN REMOTE	51-CIP-V-0103	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-009	
661	DO	51CIPYC0001	ENABLE	RO CIP PUMP STATION DISCHARGE HEADER EDUCTOR ENABLE	51-CIP-EDC-0001	51-RO-PLC-0001	N/A	N/A	N/A	N/A	EANABLE	FIELD	No	51-I-009	
662	DO	51CIPYC0001	CIP TNK LWCO	RO CIP PUMP STATION DISCHARGE HEADER EDUCTOR CIP TANK LWCO	51-CIP-EDC-0001	51-RO-PLC-0001	N/A	N/A	N/A	N/A	TANK LWCO	FIELD	No	51-I-009	
663	DO	51CIPUCR0001	RUN CMD	NEUTRALIZATION TANK CIP-T-0201 MIXER IN RUN CMD	51-CIP-MXR-0201	51-RO-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-009	
664	DO	51CIPZCO0103	OPEN CMD	RO PERMEATE (MAKEUP) TO CIP MAKEUP TANK CIP-T-0101 VALVE OPEN CMD	51-CIP-V-0103	51-RO-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-009	
665	DO	51CIPZCC0103	CLOSE CMD	RO PERMEATE (MAKEUP) TO CIP MAKEUP TANK CIP-T-0101 VALVE CLOSE CMD	51-CIP-V-0103	51-RO-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-009	
666	DI	51ROUA0001	FAIL	PROCESS BUILDING TEMP CONTROL PANEL	51-RO-TCP-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-010	
667	AI	51CIPAI0001	pH	RO CIP PUMP STATION DISCHARGE HEADER Ph	51-CIP-AIT-0001	51-RO-PLC-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	51-I-010	
668	AI	51CIPFI0001	FLOW	RO CIP PUMP STATION DISCHARGE HEADER FLOW	51-CIP-FIT-0001	51-RO-PLC-0001	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-010	
669	AI	51CIPTI0001	TEMP	RO CIP PUMP STATION DISCHARGE HEADER TEMPERATURE	51-CIP-TIT-0001	51-RO-PLC-0001	4-20mA		2-WIRE	N/A	N/A	N/A	No	51-I-010	
670	AI	51CIPSI0101	SPEED FEEDBACK	RO CIP PUMP NO 1 SPEED INDICATION	51-RO-VFD-0101	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	Yes	51-I-010	
671	AI	51CIPSI0201	SPEED FEEDBACK	RO CIP PUMP NO 2 SPEED INDICATION	51-RO-VFD-0201	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	Yes	51-I-010	
672	AO	51CIPSC0101	SPEED SETPT	RO CIP PUMP NO 1 SPEED SET POINT	51-RO-VFD-0101	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-010	
673	AO	51CIPSC0201	SPEED SETPT	RO CIP PUMP NO 2 SPEED SET POINT	51-RO-VFD-0201	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-010	
674	DI	51CIPYA0001	FAIL	RO CIP PUMP STATION DISCHARGE HEADER Ph ANALYZER FAIL	51-CIP-AIT-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-010	
675	DI	51CIPPDAH0001	DIFF. PRESSURE	RO CIP PS DISCHARGE CARTRIDGE HIGH DIFFERENTIAL PRESSURE	51-CIP-PDSH-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	HI DIFF PRESSURE	PLC	No	51-I-010	
676	DI	51CIPPAH0001	HI PRESSURE	RO CIP PS DISCHARGE HEADER HIGH PRESSURE	51-CIP-PSH-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	51-I-010	
677	DI	51CIPYIR0101	RUNNING	RO CIP PUMP NO 1 RUNNING	51-RO-VFD-0101	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-010	
678	DI	51CIPYA0101	FAIL	RO CIP PUMP NO 1 FAIL	51-RO-VFD-0101	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-010	
679	DI	51CIPYI0101	IN REMOTE	RO CIP PUMP NO 1 IN REMOTE	51-RO-VFD-0101	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-010	
680	DI	51CIPYIR0201	RUNNING	RO CIP PUMP NO 2 RUNNING	51-RO-VFD-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-010	
681	DI	51CIPYA0201	FAIL	RO CIP PUMP NO 2 FAIL	51-RO-VFD-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-010	
682	DI	51CIPYI0201	IN REMOTE	RO CIP PUMP NO 2 IN REMOTE	51-RO-VFD-0201	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-010	
683	DO	51CIPUCR0101	RUN CMD	RO CIP PUMP NO 1 RUN COMMAND	51-RO-VFD-0101	51-RO-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-010	
684	DO	51CIPUCR0201	RUN CMD	RO CIP PUMP NO 2 RUN COMMAND	51-RO-VFD-0201	51-RO-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-010	
685	DI	50ELECUA0002	FAIL	RO BUILDING FIRE ALARM	50-ELEC-EP-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-010	
686	DI	50ELECUA0003	FAIL	RO BUILDING TROUBLE ALARM	50-ELEC-EP-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-010	
687	AI	51ROFI0002	FLOW	RO FLUSH PUMP STATION DISCHARGE HEADER FLOW	51-RO-FIT-0002	51-RO-PLC-0001	4-20mA	BY RO MFR	4-WIRE	N/A	N/A	N/A	No	51-I-011	
688	AI	51ROLI0001	LEVEL	RO FLUSH TANK LEVEL	51-RO-LIT-0001	51-RO-PLC-0001	4-20mA	0-10.5 FT (EL 106.50-117.00)	2-WIRE	N/A	N/A	N/A	No	51-I-011	
689	AI	51ROSI0102	SPEED FEEDBACK	RO FLUSH PUMP NO 1 SPEED INDICATION	51-RO-VFD-0102	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-011	
690	AI	51ROSI0202	SPEED FEEDBACK	RO FLUSH PUMP NO 2 SPEED INDICATION	51-RO-VFD-0202	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	51-I-011	
691	AO	51ROSC0102	SPEED SETPT	RO FLUSH PUMP NO 1 SPEED SET POINT	51-RO-VFD-0102	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	Yes	51-I-011	
692	AO	51ROSC0202	SPEED SETPT	RO FLUSH PUMP NO 2 SPEED SET POINT	51-RO-VFD-0202	51-RO-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	Yes	51-I-011	
693	DI	51ROLAH0001	HI LEVEL	RO FLUSH TANK HIGH HIGH LEVEL	51-RO-LSHH-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	HI HI LEVEL	PLC	No	51-I-011	
694	DI	51ROLAL0001	LO LEVEL	RO FLUSH TANK LOW LOW LEVEL	51-RO-LSLL-0001	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	LO LO LEVEL	PLC	No	51-I-011	
695	DI	51ROZIO0013	OPEN	RO FLUSH TANK INLET VALVE OPENED	51-RO-V-0013	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	51-I-011	
696	DI	51ROZIC0013	CLOSED	RO FLUSH TANK INLET VALVE CLOSED	51-RO-V-0013	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	51-I-011	
697	DI	51ROYI0013	IN REMOTE	RO FLUSH TANK INLET VALVE IN REMOTE	51-RO-V-0013	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-011	
698	DI	51ROYI0102	IN REMOTE	RO FLUSH PUMP NO 1 IN REMOTE	51-RO-VFD-0102	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-011	
699	DI	51ROYIR0102	RUNNING	RO FLUSH PUMP NO 1 RUNNING	51-RO-VFD-0102	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-011	
700	DI	51ROUA0102	FAIL	RO FLUSH PUMP NO 1 FAIL	51-RO-VFD-0102	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-011	
701	DI	51ROYI0202	IN REMOTE	RO FLUSH PUMP NO 2 IN REMOTE	51-RO-VFD-0202	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	51-I-011	
702	DI	51ROYIR0202	RUNNING	RO FLUSH PUMP NO 2 RUNNING	51-RO-VFD-0202	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	51-I-011	
703	DI	51ROUA0202	FAIL	RO FLUSH PUMP NO 2 FAIL	51-RO-VFD-0202	51-RO-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	51-I-011	
704	DO	51ROZCO0013	OPEN CMD	RO FLUSH TANK INLET VALVE OPEN COMMAND	51-RO-V-0013	51-RO-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	51-I-011	
705	DO	51ROZCC0013	CLOSE CMD	RO FLUSH TANK INLET VALVE CLOSE COMMAND	51-RO-V-0013	51-RO-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	51-I-011	
706	DO	51ROUCR0102	RUN CMD	RO FLUSH PUMP NO 1 RUN COMMAND	51-RO-VFD-0102	51-RO-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-011	
707	DO	51ROUCR0202	RUN CMD	RO FLUSH PUMP NO 2 RUN COMMAND	51-RO-VFD-0202	51-RO-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	51-I-011	
708	AI	52UVAI0002	pH	UV SYSTEM INLET POST CHEM DOSING pH	52-UV-AIT-0002	52-UV-PLC-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	52-I-001	
709	AI	52UVAI0004	FREE CL2	UV SYSTEM UNITS INLET FREE CHLORINE	52-UV-AIT-0004	52-UV-PLC-0001	4-20mA	0-10 mg/L	4-WIRE	N/A	N/A	N/A	No	52-I-001	
710	AI	52UVAI0005	UVT ANALYZER	UV SYSTEM UNITS INLET UVT	52-UV-AIT-0005	52-UV-PLC-0001	4-20mA	BY UV AOP MFR	4-WIRE	N/A	N/A	N/A	No	52-I-001	
711	AI	52UVAI0007	pH	UV SYSTEM OUTLET pH	52-UV-AIT-0007	52-UV-PLC-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	52-I-001	
712	AI	52UVFI0001	FLOW	UV SYSTEM OUTLET FLOW	52-UV-FIT-0001	52-UV-PLC-0001	4-20mA	0-1.00 MGD	4-WIRE	N/A	N/A	N/A	No	52-I-001	
713	DI	52UVZIO0012	OPEN	EFFLUENT FLOW TO CALCITE FILTERS VALVE OPENED	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	52-I-001	
714	DI	52UVZIC0012	CLOSED	EFFLUENT FLOW TO CALCITE FILTERS VALVE CLOSED	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	52-I-001	
715	DI	52UVYI0012	IN REMOTE	EFFLUENT FLOW TO CALCITE FILTERS VALVE IN REMOTE	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	52-I-001	
716	DI	52ROPZIO0005	OPEN	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE OPENED	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	52-I-001	
717	DI	52ROPZIC0005	CLOSED	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE CLOSED	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	52-I-001	
718	DI	52ROPYI0005	IN REMOTE	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE IN REMOTE	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	52-I-001	

INPUT/OUTPUT LIST - MORRO BAY WRF

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
719	DI	52UVZIO0013	OPEN	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE OPENED	52-UV-V-0013	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	Yes	52-I-001	
720	DI	52UVZIC0013	CLOSED	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE CLOSED	52-UV-V-0013	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	52-I-001	
721	DI	52UVYI0013	IN REMOTE	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE IN REMOTE	52-UV-V-0013	52-UV-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	52-I-001	
722	DO	52UVZCO0012	OPEN CMD	EFFLUENT FLOW TO CALCITE FILTERS VALVE OPEN COMMAND	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	52-I-001	
723	DO	52UVZCC0012	CLOSE CMD	EFFLUENT FLOW TO CALCITE FILTERS VALVE CLOSE COMMAND	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	52-I-001	
724	DO	52ROPZCO0005	OPEN CMD	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE OPEN CMD	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	52-I-001	
725	DO	52ROPZCC0005	CLOSE CMD	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE CLOSE CMD	52-UV-V-0012	52-UV-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	52-I-001	
726	DO	52UVZCO0013	OPEN CMD	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE OPEN COMMAND	52-UV-V-0013	52-UV-PLC-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	52-I-001	
727	DO	52UVZCC0013	CLOSE CMD	EFFLUENT FLOW TO OUTFALL BALANCING TANK VALVE CLOSE COMMAND	52-UV-V-0013	52-UV-PLC-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	52-I-001	
728	AI	61CALFI0001	FLOW	SEWER OR STORM DRAIN FLOW	61-CAL-FIT-0001	51-CTRL-RIO-0001	4-20mA	0-300 GPM	4-WIRE	N/A	N/A	N/A	No	61-I-001	
729	AI	61CALLI0101	LEVEL	BACKWASH WASTE HOLDING TANK LEVEL	61-CAL-LIT-0001	51-CTRL-RIO-0001	4-20mA	0-XX FT	4-WIRE	N/A	N/A	N/A	No	61-I-001	
730	AI	61CALSI0001	SPEED FEEDBACK	CALCITE VESSEL FLUSH PUMP SPEED FEEDBACK	61-CAL-VFD-0001	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	61-I-001	
731	AO	61CALSC0001	SPEED SETPT	CALCITE VESSEL FLUSH PUMP SPEED SET POINT	61-CAL-VFD-0001	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	61-I-001	
732	DI	61CALPDAH0101	DIFF. PRESSURE	CALCITE VESSEL NO 1 HIGH DIFFERENTIAL PRESSURE	61-CAL-PDS-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HIGH DIFF PRESSURE	PLC	No	61-I-001	
733	DI	61CALPDAH0201	DIFF. PRESSURE	CALCITE VESSEL NO 2 HIGH DIFFERENTIAL PRESSURE	61-CAL-PDS-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HIGH DIFF PRESSURE	PLC	No	61-I-001	
734	DI	61CALYI0001	IN REMOTE	BACKWASH WASTE HOLDING TANK DRAIN VALVE IN REMOTE	61-CAL-V-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	61-I-001	
735	DI	61CALZIO0001	OPEN	BACKWASH WASTE HOLDING TANK DRAIN VALVE OPENED	61-CAL-V-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	61-I-001	
736	DI	61CALZIC0001	CLOSED	BACKWASH WASTE HOLDING TANK DRAIN VALVE CLOSED	61-CAL-V-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	61-I-001	
737	DI	61CALYI0001	IN REMOTE	CALCITE VESSEL FLUSH PUMP IN REMOTE	61-CAL-VFD-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	61-I-001	
738	DI	61CALYIR0001	RUNNING	CALCITE VESSEL FLUSH PUMP RUNNING	61-CAL-VFD-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	61-I-001	
739	DI	61CALYA0001	FAIL	CALCITE VESSEL FLUSH PUMP FAIL	61-CAL-VFD-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	61-I-001	
740	DI	61CALYA0001	OVERLOAD	CALCITE VESSEL FLUSH PUMP OVERLOAD ALARM	61-CAL-VFD-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OVERLOAD	PLC	No	61-I-001	
741	DI	61CALTAH0001	HI TEMP	CALCITE VESSEL FLUSH PUMP TEMP HIGH	61-CAL-VFD-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	TEMP HI	PLC	No	61-I-001	
742	DO	61CALZCO0001	OPEN CMD	BACKWASH WASTE HOLDING TANK DRAIN VALVE OPEN COMMAND	61-CAL-V-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	61-I-001	
743	DO	61CALZCC0001	CLOSE CMD	BACKWASH WASTE HOLDING TANK DRAIN VALVE CLOSE COMMAND	61-CAL-V-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	61-I-001	
744	DO	61CALUCR0001	RUN CMD	CALCITE VESSEL FLUSH PUMP RUN COMMAND	61-CAL-VFD-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	61-I-001	
745	AI	61CALAI0001	pH	CALCITE FILTER INLET HEADER pH	61-CAL-AIT-0001	61-CTRL-RIO-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	61-I-001	
746	AI	61CALAI0002	pH	CALCITE FILTER OUTLET HEADER pH	61-CAL-AIT-0002	61-CTRL-RIO-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	61-I-001	
747	AI	62TWLI0001	LEVEL	STORAGE TANK LEVEL	62-TW-LIT-0001	51-CTRL-RIO-0001	4-20mA	0-19.0 FT (EL 104.00-123.00	2-WIRE	N/A	N/A	N/A	No	62-I-001	
748	DI	62TWLAHH0001	HI-HI LEVEL	STORAGE TANK HIGH HIGH LEVEL	62-TW-LSHH-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI HI LEVEL	PLC	No	62-I-001	
749	DI	62TWLALL0001	LO-LO LEVEL	STORAGE TANK LOW LOW LEVEL	62-TW-LSLL-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LO LO LEVEL	PLC	No	62-I-001	
750	AI	63TWSI0101	SPEED FEEDBACK	IPR PUMP NO 1 SPEED FEEDBACK	63-IPR-VFD-0101	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	63-I-001	
751	AI	63TWSI0201	SPEED INDCTN	IPR PUMP NO 2 SPEED FEEDBACK	63-IPR-VFD-0201	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	63-I-001	
752	AI	63TWSI0301	SPEED INDCTN	IPR PUMP NO 3 SPEED FEEDBACK	63-IPR-VFD-0301	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	63-I-001	
753	AI	63TWAI0001	CL2	IPR PRODUCT WATER DISCHARGE HEADER TOTAL CHLORINE	63-TW-AIT-0001	51-CTRL-RIO-0001	4-20mA	0-10 mg/L	4-WIRE	N/A	N/A	N/A	No	63-I-001	
754	AI	63TWAI0002	COND	IPR PRODUCT WATER DISCHARGE HEADER CONDUCTIVITY	63-TW-AIT-0002	51-CTRL-RIO-0001	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	63-I-001	
755	AI	63TWAI0003	pH	IPR PRODUCT WATER DISCHARGE HEADER pH	63-TW-AIT-0003	51-CTRL-RIO-0001	4-20mA	0-14 pH	4-WIRE	N/A	N/A	N/A	No	63-I-001	
756	AI	63TWFI0001	FLOW	IPR PUMP STATION DISCHARGE HEADER FLOW	63-TW-FIT-0001	51-CTRL-RIO-0001	4-20mA	0-1.00 MGD	4-WIRE	N/A	N/A	N/A	No	63-I-001	
757	AI	63TWPI0001	PRESSURE	IPR PUMP STATION DISCHARGE HEADER PRESSURE	63-TW-PIT-0001	51-CTRL-RIO-0001	4-20mA	0-100 PSI	2-WIRE	N/A	N/A	N/A	No	63-I-001	
758	AO	63TWSC0101	SPEED SETPT	IPR PUMP NO 1 SPEED SET POINT	63-IPR-VFD-0101	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	63-I-001	
759	AO	63TWSC0201	SPEED SETPT	IPR PUMP NO 2 SPEED SET POINT	63-IPR-VFD-0201	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	63-I-001	
760	AO	63TWSC0301	SPEED SETPT	IPR PUMP NO 3 SPEED SET POINT	63-IPR-VFD-0301	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	63-I-001	
761	DI	63TWYI0101	IN REMOTE	IPR PUMP NO 1 IN REMOTE	63-IPR-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	63-I-001	
762	DI	63TWYIR0101	RUNNING	IPR PUMP NO 1 RUNNING	63-IPR-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	63-I-001	
763	DI	63TWYA0101	FAIL	IPR PUMP NO 1 FAIL	63-IPR-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	63-I-001	
764	DI	63TWYI0201	IN REMOTE	IPR PUMP NO 2 IN REMOTE	63-IPR-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	63-I-001	
765	DI	63TWYIR0201	RUNNING	IPR PUMP NO 2 RUNNING	63-IPR-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	63-I-001	
766	DI	63TWUA0201	FAIL	IPR PUMP NO 2 FAIL	63-IPR-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	63-I-001	
767	DI	63TWYI0301	IN REMOTE	IPR PUMP NO 3 IN REMOTE	63-IPR-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	63-I-001	
768	DI	63TWYIR0301	RUNNING	IPR PUMP NO 3 RUNNING	63-IPR-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	63-I-001	
769	DI	63TWUA0301	FAIL	IPR PUMP NO 3 FAIL	63-IPR-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	63-I-001	
770	DI	63TWYA0001	FAIL	IPR PRODUCT WATER DISCHARGE HEADER TOTAL CHLORINE ANALYZER FAIL ALA	63-TW-AIT-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	63-I-001	
771	DI	63TWYA0002	FAIL	IPR PRODUCT WATER DISCHARGE HEADER CONDUCTIVITY ANALYZER FAIL ALARI	63-TW-AIT-0002	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	63-I-001	
772	DI	63TWYA0003	FAIL	IPR PRODUCT WATER DISCHARGE HEADER pH ANALYZER FAIL ALARM	63-TW-AIT-0003	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	63-I-001	
773	DO	63TWUCR0101	RUN CMD	IPR PUMP NO 1 RUN COMMAND	63-IPR-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	63-I-001	
774	DO	63TWUCR0201	RUN CMD	IPR PUMP NO 2 RUN COMMAND	63-IPR-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	63-I-001	
775	DO	63TWUCR0301	RUN CMD	IPR PUMP NO 3 RUN COMMAND	63-IPR-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	63-I-001	
776	AI	64TWFI0001	FLOW	OUTFALL PUMP STATION DISCHARGE HEADER FLOW	64-TW-FIT-0001	51-CTRL-RIO-0001	4-20mA	0-7,500 GPM	4-WIRE	N/A	N/A	N/A	No	64-I-001	
777	AI	64TWPI0001	PRESSURE	OUTFALL PUMP STATION DISCHARGE HEADER PRESSURE	64-TW-PIT-0001	51-CTRL-RIO-0001	4-20mA	0-100 PSI	2-WIRE	N/A	N/A	N/A	No	64-I-001	
778	AI	64TWLI0001	LEVEL	OUTFALL BALANCING TANK LEVEL	64-TW-LIT-0001	51-CTRL-RIO-0001	4-20mA	0-18 FT (EL 104.00-122.00)	2-WIRE	N/A	N/A	N/A	No	64-I-001	
779	AI	64TWSI0101	SPEED FEEDBACK	OUTFALL PUMP NO 1 SPEED FEEDBACK	64-TW-VFD-0101	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	64-I-001	
780	AI	64TWSI0201	SPEED INDCTN	OUTFALL PUMP NO 2 SPEED FEEDBACK	64-TW-VFD-0201	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	64-I-001	
781	AI	64TWSI0301	SPEED INDCTN	OUTFALL PUMP NO 3 SPEED FEEDBACK	64-TW-VFD-0301	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	64-I-001	
782	AI	64TWSI0401	SPEED INDCTN	OUTFALL PUMP NO 4 SPEED FEEDBACK	64-TW-VFD-0401	51-CTRL-RIO-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	64-I-001	
783	AO	64TWSC0101	SPEED SETPT	OUTFALL PUMP NO 1 SPEED SET POINT	64-TW-VFD-0101	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	64-I-001	
784	AO	64TWSC0201	SPEED SETPT	OUTFALL PUMP NO 2 SPEED SET POINT	64-TW-VFD-0201	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	64-I-001	
785	AO	64TWSC0301	SPEED SETPT	OUTFALL PUMP NO 3 SPEED SET POINT	64-TW-VFD-0301	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	64-I-001	
786	AO	64TWSC0401	SPEED SETPT	OUTFALL PUMP NO 4 SPEED SET POINT	64-TW-VFD-0401	51-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	64-I-001	
787	DI	64TWLSL0001	LOW LEVEL	OUTFALL BALANCING TANK LEVEL HIGH	64-TW-LSH-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEVEL LOW	PLC	No	64-I-001	
788	DI	64TWLAH0001	HI LEVEL	OUTFALL BALANCING TANK LEVEL HIGH HIGH	64-TW-LSHH-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEVEL HIGH	PLC	No	64-I-001	
789	DI	64TWYI0101	IN REMOTE	OUTFALL PUMP NO 1 IN REMOTE	64-TW-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	64-I-001	
790	DI	64TWYIR0101	RUNNING	OUTFALL PUMP NO 1 RUNNING	64-TW-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	64-I-001	
791	DI	64TWYA0101	FAULT	OUTFALL PUMP NO 1 FAIL	64-TW-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	64-I-001	
792	DI	64TWYI0201	IN REMOTE	OUTFALL PUMP NO 2 IN REMOTE	64-TW-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	64-I-001	

INPUT/OUTPUT LIST - MORRO BAY WRF

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
793	DI	64TWYIR0201	RUNNING	OUTFALL PUMP NO 2 RUNNING	64-TW-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	64-I-001	
794	DI	64TWYA0201	FAULT	OUTFALL PUMP NO 2 FAIL	64-TW-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	64-I-001	
795	DI	64TWYI0301	IN REMOTE	OUTFALL PUMP NO 3 IN REMOTE	64-TW-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	64-I-001	
796	DI	64TWYIR0301	RUNNING	OUTFALL PUMP NO 3 RUNNING	64-TW-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	64-I-001	
797	DI	64TWYA0301	FAULT	OUTFALL PUMP NO 3 FAIL	64-TW-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	64-I-001	
798	DI	64TWYI0401	IN REMOTE	OUTFALL PUMP NO 4 IN REMOTE	64-TW-VFD-0401	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	64-I-001	
799	DI	64TWYIR0401	RUNNING	OUTFALL PUMP NO 4 RUNNING	64-TW-VFD-0401	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	64-I-001	
800	DI	64TWYA0401	FAULT	OUTFALL PUMP NO 4 FAIL	64-TW-VFD-0401	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	64-I-001	
801	DO	64TWUCR0101	RUN CMD	OUTFALL PUMP NO 1 RUN COMMAND	64-TW-VFD-0101	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	64-I-001	
802	DO	64TWUCR0201	RUN CMD	OUTFALL PUMP NO 2 RUN COMMAND	64-TW-VFD-0201	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	64-I-001	
803	DO	64TWUCR0301	RUN CMD	OUTFALL PUMP NO 3 RUN COMMAND	64-TW-VFD-0301	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	64-I-001	
804	DO	64TWUCR0401	RUN CMD	OUTFALL PUMP NO 4 RUN COMMAND	64-TW-VFD-0401	51-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	64-I-001	
805	AI	65TWAI0004	CL2	OUTFALL PUMP STATION DISCHARGE HEADER FREE CHLORINE	65-TW-AIT-0004	51-CTRL-RIO-0001	4-20mA	0-10 mg/L	4-WIRE	N/A	N/A	N/A	No	65-I-001	
806	AO	65TWFI0001	FLOW	COMPOSITE SAMPLER FLOW NEAR OCEAN OUTFALL SET POINT	65-TW-SAMP-0001	51-CTRL-RIO-0001	4-20mA		2-WIRE	N/A	N/A	N/A	No	65-I-001	
807	DI	65TWYA0004	FAIL	OUTFALL PUMP STATION DISCHARGE HEADER FREE CHLORINE ANALYZER FAIL	65-TW-AIT-0004	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	65-I-001	
808	DI	65TWFA0001	TRBL	COMPOSITE SAMPLER FLOW NEAR OCEAN OUTFALL IN TROUBLE	65-TW-SAMP-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN TROUBLE	PLC	No	65-I-001	
809	AI	71WASAI0101	DO	SLUDGE HOLDING TANK NO 1 DISSOLVED OXEGEN	71-WAS-AIT-0101	72-CTRL-RIO-0001	4-20mA	0-20 mg/L	4-WIRE	N/A	N/A	N/A	No	71-I-001	
810	AI	71WASAI0201	DO	SLUDGE HOLDING TANK NO 2 DISSOLVED OXEGEN	71-WAS-AIT-0201	72-CTRL-RIO-0001	4-20mA	0-20 mg/L	4-WIRE	N/A	N/A	N/A	No	71-I-001	
811	AI	71WASLI0101	LEVEL	SLUDGE HOLDING TANK NO 1 LEVEL	71-WAS-LIT-0101	72-CTRL-RIO-0001	4-20mA	0-23.0 FT (EL 111.25-134.25)	4-WIRE	N/A	N/A	N/A	No	71-I-001	
812	AI	71WASLI0201	LEVEL	SLUDGE HOLDING TANK NO 2 LEVEL	71-WAS-LIT-0201	72-CTRL-RIO-0001	4-20mA	0-23.0 FT (EL 111.25-134.25)	4-WIRE	N/A	N/A	N/A	No	71-I-001	
813	DI	71WASYA0101	FAIL	SLUDGE HOLDING TANK NO 1 DO ANALYZER FAIL	71-WAS-AIT-0101	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	71-I-001	
814	DI	71WASYA0201	FAIL	SLUDGE HOLDING TANK NO 2 DO ANALYZER FAIL	71-WAS-AIT-0201	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	71-I-001	
815	DI	71WASYA0101	FAIL	SLUDGE HOLDING TANK NO 1 MIXER FAIL	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	71-I-001	
816	DI	71WASYIR0101	RUNNING	SLUDGE HOLDING TANK NO 1 MIXER RUNNING	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	71-I-001	
817	DI	71WASYA0201	FAIL	SLUDGE HOLDING TANK NO 2 MIXER FAIL	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	71-I-001	
818	DI	71WASYIR0201	RUNNING	SLUDGE HOLDING TANK NO 2 MIXER RUNNING	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	71-I-001	
819	DI	71WASYI0101	IN REMOTE	SLUDGE HOLDING TANK NO 1 MIXER IN REMOTE	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	71-I-001	
820	DI	71WASYI0201	IN REMOTE	SLUDGE HOLDING TANK NO 2 MIXER IN REMOTE	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	71-I-001	
821	DO	71WASUCR0101	RUN CMD	SLUDGE HOLDING TANK NO 1 MIXER RUN COMMAND	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	71-I-001	
822	DO	71WASUCR0201	RUN CMD	SLUDGE HOLDING TANK NO 2 MIXER RUN COMMAND	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	71-I-001	
823	AI	71WASLI0001	LEVEL	SAFE SETTLE TANK LEVEL	71-WAS-LIT-0001	72-CTRL-RIO-0001	4-20mA	0-23.0 FT (EL 111.25-134.25)	4-WIRE	N/A	N/A	N/A	No	71-I-002	
824	AI	71AIRPI0102	PRESSURE	SLUDGE HOLDING TANK BLOWER NO 1 DISCHARGE PRESSURE	71-AIR-PIT-0102	72-CTRL-RIO-0001	4-20mA	0-15 PSI	2-WIRE	N/A	N/A	N/A	No	71-I-003	
825	AI	71AIRPI0202	PRESSURE	SLUDGE HOLDING TANK BLOWER NO 2 DISCHARGE PRESSURE	71-AIR-PIT-0202	72-CTRL-RIO-0001	4-20mA	0-15 PSI	2-WIRE	N/A	N/A	N/A	No	71-I-003	
826	AI	71AIRSI0101	SPEED INDCTN	SLUDGE HOLDING TANK BLOWER NO 1 SPEED INDICATION	71-AIR-VFD-0101	80-CTRL-PLC-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	71-I-003	
827	AI	71AIRSI0201	SPEED INDCTN	SLUDGE HOLDING TANK BLOWER NO 2 SPEED INDICATION	71-AIR-VFD-0201	80-CTRL-PLC-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	71-I-003	
828	AO	71AIRSC0101	SPEED CONTROL	SLUDGE HOLDING TANK BLOWER NO 1 SPEED SET PT	71-AIR-VFD-0101	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	71-I-003	
829	AO	71AIRSC0201	SPEED CONTROL	SLUDGE HOLDING TANK BLOWER NO 2 SPEED SET PT	71-AIR-VFD-0201	80-CTRL-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	71-I-003	
830	DI	71AIRYIR0101	RUNNING	SLUDGE HOLDING TANK BLOWER NO 1 RUNNING	71-AIR-VFD-0101	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	71-I-003	
831	DI	71AIRYA0101	FAIL	SLUDGE HOLDING TANK BLOWER NO 1 FAIL	71-AIR-VFD-0101	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	71-I-003	
832	DI	71AIRYI0101	IN REMOTE	SLUDGE HOLDING TANK BLOWER NO 1 IN REMOTE	71-AIR-VFD-0101	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	71-I-003	
833	DI	71AIRYIR0201	RUNNING	SLUDGE HOLDING TANK BLOWER NO 2 RUNNING	71-AIR-VFD-0201	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	71-I-003	
834	DI	71AIRYA0201	FAIL	SLUDGE HOLDING TANK BLOWER NO 2 FAIL	71-AIR-VFD-0201	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	71-I-003	
835	DI	71AIRYI0201	IN REMOTE	SLUDGE HOLDING TANK BLOWER NO 2 IN REMOTE	71-AIR-VFD-0201	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	71-I-003	
836	DO	71AIRUCR0101	RUN CMD	SLUDGE HOLDING TANK BLOWER NO 1 RUN COMMAND	71-AIR-VFD-0101	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	71-I-003	
837	DO	71AIRUCR0201	RUN CMD	SLUDGE HOLDING TANK BLOWER NO 2 RUN COMMAND	71-AIR-VFD-0201	80-CTRL-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	71-I-003	
838	AI	72DWTFI0001	FLOW	DEWATERING SLUDGE FEED PUMP DISCHARGE FLOW	72-DWT-FIT-0001	72-DWT-PLC-0001	4-20mA	0-350 GPM	4-WIRE	N/A	N/A	N/A	No	72-I-001	
839	AI	72DWTSI0101	SPEED FEEDBACK	DEWATERING SLUDGE FEED PUMP NO 1 SPEED FEEDBACK	72-DWT-LCP-0101	72-DWT-PLC-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	72-I-001	
840	AI	72DWTSI0201	SPEED FEEDBACK	DEWATERING SLUDGE FEED PUMP NO 2 SPEED FEEDBACK	72-DWT-LCP-0201	72-DWT-PLC-0001	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	No	72-I-001	
841	AO	72DWTSC0101	SPEED SETPT	DEWATERING SLUDGE FEED PUMP NO 1 SPEED SET PT	72-DWT-LCP-0101	72-DWT-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	72-I-001	
842	AO	72DWTSC0201	SPEED SETPT	DEWATERING SLUDGE FEED PUMP NO 2 SPEED SET PT	72-DWT-LCP-0201	72-DWT-PLC-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	72-I-001	
843	DI	72DWTYI0101	IN REMOTE	DEWATERING SLUDGE FEED PUMP NO 1 IN REMOTE	72-DWT-LCP-0101	72-DWT-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	72-I-001	
844	DI	72DWTYIR0101	RUNNING	DEWATERING SLUDGE FEED PUMP NO 1 RUNNING	72-DWT-LCP-0101	72-DWT-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	72-I-001	
845	DI	72DWTYA0101	FAIL	DEWATERING SLUDGE FEED PUMP NO 1 FAIL	72-DWT-LCP-0101	72-DWT-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	72-I-001	
846	DI	72DWTYI0201	IN REMOTE	DEWATERING SLUDGE FEED PUMP NO 2 IN REMOTE	72-DWT-LCP-0201	72-DWT-PLC-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	72-I-001	
847	DI	72DWTYIR0201	RUNNING	DEWATERING SLUDGE FEED PUMP NO 2 RUNNING	72-DWT-LCP-0201	72-DWT-PLC-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	72-I-001	
848	DI	72DWTYA0201	FAIL	DEWATERING SLUDGE FEED PUMP NO 2 FAIL	72-DWT-LCP-0201	72-DWT-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	72-I-001	
849	DO	72DWTUCR0101	RUN CMD	DEWATERING SLUDGE FEED PUMP NO 1 RUN COMMAND	72-DWT-LCP-0101	72-DWT-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	72-I-001	
850	DO	72DWTUCR0201	RUN CMD	DEWATERING SLUDGE FEED PUMP NO 2 RUN COMMAND	72-DWT-LCP-0201	72-DWT-PLC-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	72-I-001	
851	DI	72DWTYIR0001	RUNNING	BELT FILTER PRESS RUNNING	72-DWT-LCP-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	No	72-I-002	
852	DI	72DWTYA0001	FAIL	BELT FILTER PRESS FAIL	72-DWT-LCP-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	FAIL	PLC	No	72-I-002	
853	DI	72DWTUA0001	SHUTDOWN ALARM	BELT FILTER PRESS SHUTDOWN ALARM	72-DWT-LCP-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	SHUTDOWN ALARM	PLC	No	72-I-002	
854	DI	72DWTYIA0001	ESTOP	BELT FILTER PRESS E-STOP	72-DWT-LCP-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	E-STOP	PLC	No	72-I-002	
855	DI	72DWTPAL0001	LOW PRESSURE	BELT FILTER PRESS LOW PRESSURE	72-DWT-LCP-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	LOW PRESSURE	PLC	No	72-I-002	
856	DI	72DWTYA0001	FAIL	BELT FILTER PRESS WARNING	72-DWT-LCP-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	WARNING	PLC	No	72-I-002	
857	DI	72DWTYIA0002	ESTOP	DEWATERING SCREW CONVEYOR NO 2 E-STOP	72-DWT-LCP-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	E-STOP	PLC	No	72-I-002	
858	DI	72DWTSI0002	ZERO SPEED	DEWATERING SCREW CONVEYOR NO 2 ZERO SPEED	72-DWT-LCP-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	ZERO SPEED	PLC	No	72-I-002	
859	DI	72DWTIA0002	MOTOR OVLD	DEWATERING SCREW CONVEYOR NO 2 MOTOR OVERLOAD	72-DWT-LCP-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	MOTOR OVERLOAD	PLC	No	72-I-002	
860	DI	72DWTYIR0002	RUNNING	DEWATERING SCREW CONVEYOR NO 2 RUNNING	72-DWT-LCP-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	72-I-002	
861	DI	72DWTYI0002	IN REMOTE	DEWATERING SCREW CONVEYOR NO 2 IN REMOTE	72-DWT-LCP-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	72-I-002	
862	DI	72DWTYIA0003	ESTOP	DEWATERING SCREW CONVEYOR NO 3 E-STOP	72-DWT-LCP-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	E-STOP	PLC	No	72-I-002	
863	DI	72DWTSI0003	ZERO SPEED	DEWATERING SCREW CONVEYOR NO 3 ZERO SPEED	72-DWT-LCP-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	ZERO SPEED	PLC	No	72-I-002	
864	DI	72DWTIA0003	MOTOR OVLD	DEWATERING SCREW CONVEYOR NO 3 MOTOR OVERLOAD	72-DWT-LCP-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	MOTOR OVERLOAD	PLC	No	72-I-002	
865	DI	72DWTYIR0003	RUNNING	DEWATERING SCREW CONVEYOR NO 3 RUNNING	72-DWT-LCP-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	72-I-002	

INPUT/OUTPUT LIST - MORRO BAY WRF

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
866	DI	72DWTYI0003	IN REMOTE	DEWATERING SCREW CONVEYOR NO 3 IN REMOTE	72-DWT-LCP-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	72-I-002	
867	DI	72DWTYIA0001	ESTOP	DEWATERING SCREW CONVEYOR NO 1 E-STOP	72-DWT-LCP-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	E-STOP	PLC	No	72-I-002	
868	DI	72DWTSI0001	ZERO SPEED	DEWATERING SCREW CONVEYOR NO 1 ZERO SPEED	72-DWT-LCP-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	ZERO SPEED	PLC	No	72-I-002	
869	DI	72DWTIA0001	MOTOR OVLD	DEWATERING SCREW CONVEYOR NO 1 MOTOR OVERLOAD	72-DWT-LCP-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	MOTOR OVERLOAD	PLC	No	72-I-002	
870	DI	72DWTYIR0001	RUNNING	DEWATERING SCREW CONVEYOR NO 1 RUNNING ?????	72-DWT-LCP-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	72-I-002	
871	DI	72DWTYI0001	IN REMOTE	DEWATERING SCREW CONVEYOR NO 1 IN REMOTE	72-DWT-LCP-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	72-I-002	
872	DI	72DWTYI0006	IN REMOTE	BELT FILTER INLET VALVE IN REMOTE	72-DWT-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	72-I-002	
873	DI	72DWTZIO0006	OPEN	BELT FILTER INLET VALVE OPENED	72-DWT-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	72-I-002	
874	DI	72DWTZIC0006	CLOSED	BELT FILTER INLET VALVE CLOSED	72-DWT-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	72-I-002	
875	DI	72DWTYI0201	IN REMOTE	DEWATERING GATE NO 2 IN REMOTE	72-DWT-V-0201	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	72-I-002	
876	DI	72DWTZIO0201	OPEN	DEWATERING GATE NO 2 OPENED	72-DWT-V-0201	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	72-I-002	
877	DI	72DWTZIC0201	CLOSED	DEWATERING GATE NO 2 CLOSED	72-DWT-V-0201	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	72-I-002	
878	DO	72DWTUCR0002	RUN CMD	DEWATERING SCREW CONVEYOR NO 2 RUN COMMAND	72-DWT-LCP-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	72-I-002	
879	DO	72DWTUCR0003	RUN CMD	DEWATERING SCREW CONVEYOR NO 3 RUN COMMAND	72-DWT-LCP-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	72-I-002	
880	DO	72DWTUCR0001	RUN CMD	DEWATERING SCREW CONVEYOR NO 1 RUN COMMAND	72-DWT-LCP-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	72-I-002	
881	DO	72DWTZCO0006	OPEN CMD	BELT FILTER INLET VALVE OPEN COMMAND	72-DWT-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	72-I-002	
882	DO	72DWTZCC0006	CLOSE CMD	BELT FILTER INLET VALVE CLOSE COMMAND	72-DWT-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	72-I-002	
883	DO	72DWTZCO0201	OPEN CMD	DEWATERING GATE NO 2 OPEN COMMAND	72-DWT-V-0201	72-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	72-I-002	
884	DO	72DWTZCC0201	CLOSE CMD	DEWATERING GATE NO 2 CLOSE COMMAND	72-DWT-V-0201	72-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	72-I-002	
885	AI	73FSWAI0001	pH	DISK FILTER PH	73-FSW-AIT-0001	72-CTRL-RIO-0001	ETHERNET	0-14 pH	N/A	N/A	N/A	N/A	No	73-I-001	
886	AI	73FSWFI0001	FLOW	DISK FILTER OVERFLOW EFFLUENT FLOW	73-FSW-FIT-0001	72-CTRL-RIO-0001	ETHERNET	BY FILTER MFR	N/A	N/A	N/A	N/A	No	73-I-001	
887	AI	73FSWFI0002	FLOW	FILTER SOLID WASTE PUMP DISCHARGE FLOW	73-FSW-FIT-0002	72-CTRL-RIO-0001	ETHERNET	0-500 GPM	N/A	N/A	N/A	N/A	No	73-I-001	
888	AI	73FSWFI0003	FLOW	FILTER BACKWASH WASTE PUMP DISCHARGE FLOW	73-FSW-FIT-0003	72-CTRL-RIO-0001	ETHERNET	0-500 GPM	N/A	N/A	N/A	N/A	No	73-I-001	
889	AI	73FSWLI0001	LEVEL	DISK FILTER LEVEL	73-FSW-LIT-0001	72-CTRL-RIO-0001	ETHERNET	BY FILTER MFR	N/A	N/A	N/A	N/A	No	73-I-001	
890	AI	73FSWPI0001	PRESSURE	FILTER SOLID WASTE PUMP SUCTION PRESSURE	73-FSW-PIT-0001	72-CTRL-RIO-0001	ETHERNET	BY FILTER MFR	N/A	N/A	N/A	N/A	No	73-I-001	
891	AI	73FSWPI0002	PRESSURE	FILTER BACKWASH WASTE PUMP SUCTION PRESSURE	73-FSW-PIT-0002	72-CTRL-RIO-0001	ETHERNET	BY FILTER MFR	N/A	N/A	N/A	N/A	No	73-I-001	
892	AI	73FSWVI0001	VIBRATION	DISK FILTER VIBREATION	73-FSW-VIT-0001	72-CTRL-RIO-0001	ETHERNET	BY FILTER MFR	N/A	N/A	N/A	N/A	No	73-I-001	
893	DI	73FSWYI0001	IN REMOTE	DISK FILTER IN REMOTE	73-FSW-FLT-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
894	DI	73FSWYIR0001	RUNNING	DISK FILTER RUNNING	73-FSW-FLT-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	No	73-I-001	
895	DI	73FSWYA0001	FAIL	DISK FILTER FAIL	73-FSW-FLT-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	FAIL	PLC	No	73-I-001	
896	DI	73FSWFAH0001	HIGH FLOW	DISK FILTER FLOW HIGH	73-FSW-FSH-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	FLOW HIGH	PLC	No	73-I-001	
897	DI	73FSWYI0001	IN REMOTE	DISK FILTER INLET KNIFE GATE IN REMOTE	73-FSW-G-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
898	DI	73FSWZIO0001	OPEN	DISK FILTER INLET KNIFE GATE OPEN	73-FSW-G-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
899	DI	73FSWZIC0001	CLOSED	DISK FILTER INLET KNIFE GATE CLOSED	73-FSW-G-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
900	DI	73FSWLAH0001	HIGH LEVEL	DISK FILTER LEVEL HIGH	73-FSW-LSH-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	LEVEL HI	PLC	No	73-I-001	
901	DI	73FSWYI0001	IN REMOTE	FILTER SOLID WASTE PUMP IN REMOTE	73-FSW-P-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
902	DI	73FSWYIR0001	RUNNING	FILTER SOLID WASTE PUMP RUNNING	73-FSW-P-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	No	73-I-001	
903	DI	73FSWYA0001	FAIL	FILTER SOLID WASTE PUMP FAIL	73-FSW-P-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	FAIL	PLC	No	73-I-001	
904	DI	73FSWYI0002	IN REMOTE	FILTER BACKWASH WASTE PUMP IN REMOTE	73-FSW-P-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
905	DI	73FSWYIR0002	RUNNING	FILTER BACKWASH WASTE PUMP RUNNING	73-FSW-P-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	No	73-I-001	
906	DI	73FSWYA0002	FAIL	FILTER BACKWASH WASTE PUMP FAIL	73-FSW-P-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	FAIL	PLC	No	73-I-001	
907	DI	73FSWPAH0003	HI PRESSURE	FILTER SOLID WASTE PUMP DISCHARGE PRESSURE HIGH	73-FSW-PSH-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	PRESSURE HIGH	PLC	No	73-I-001	
908	DI	73FSWPAH0004	HI PRESSURE	FILTER BACKWASH WASTE PUMP DISCHARGE PRESSURE HIGH	73-FSW-PSH-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	PRESSURE HIGH	PLC	No	73-I-001	
909	DI	73FSWYI0002	IN REMOTE	FILTER SOLID WASTE PUMP SUCTION VALVE IN REMOTE	73-FSW-V-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
910	DI	73FSWZIO0002	OPEN	FILTER SOLID WASTE PUMP SUCTION VALVE OPENED	73-FSW-V-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
911	DI	73FSWZIC0002	CLOSED	FILTER SOLID WASTE PUMP SUCTION VALVE CLOSED	73-FSW-V-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
912	DI	73FSWYI0003	IN REMOTE	FILTER BACKWASH WASTE VALVE 0003 IN REMOTE	73-FSW-V-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
913	DI	73FSWZIO0003	OPEN	FILTER BACKWASH WASTE VALVE 0003 OPENED	73-FSW-V-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
914	DI	73FSWZIC0003	CLOSED	FILTER BACKWASH WASTE VALVE 0003 CLOSED	73-FSW-V-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
915	DI	73FSWYI0004	IN REMOTE	FILTER BACKWASH WASTE VALVE 0004 IN REMOTE	73-FSW-V-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
916	DI	73FSWZIO0004	OPEN	FILTER BACKWASH WASTE VALVE 0004 OPENED	73-FSW-V-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
917	DI	73FSWZIC0004	CLOSED	FILTER BACKWASH WASTE VALVE 0004 CLOSED	73-FSW-V-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
918	DI	73FSWYI0005	IN REMOTE	FILTER BACKWASH WASTE VALVE 0005 IN REMOTE	73-FSW-V-0005	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
919	DI	73FSWZIO0005	OPEN	FILTER BACKWASH WASTE VALVE 0005 OPENED	73-FSW-V-0005	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
920	DI	73FSWZIC0005	CLOSED	FILTER BACKWASH WASTE VALVE 0005 CLOSED	73-FSW-V-0005	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
921	DI	73FSWYI0006	IN REMOTE	DISK FILTER RECIRCLATION VALVE IN REMOTE	73-FSW-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
922	DI	73FSWZIO0006	OPEN	DISK FILTER RECIRCLATION VALVE OPENED	73-FSW-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
923	DI	73FSWZIC0006	CLOSED	DISK FILTER RECIRCLATION VALVE CLOSED	73-FSW-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
924	DI	73FSWYI0007	IN REMOTE	DISK FILTER SCUM VALVE IN REMOTE	73-FSW-V-0007	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
925	DI	73FSWZIO0007	OPEN	DISK FILTER SCUM VALVE OPENED	73-FSW-V-0007	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
926	DI	73FSWZIC0007	CLOSED	DISK FILTER SCUM VALVE CLOSED	73-FSW-V-0007	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
927	DI	73FSWYI0011	IN REMOTE	FILTER SOLIDS WASTE PUMP DISCHARGE VALVE IN REMOTE	73-FSW-V-0011	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
928	DI	73FSWZIO0011	OPEN	FILTER SOLIDS WASTE PUMP DISCHARGE VALVE OPENED	73-FSW-V-0011	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
929	DI	73FSWZIC0011	CLOSED	FILTER SOLIDS WASTE PUMP DISCHARGE VALVE CLOSED	73-FSW-V-0011	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
930	DI	73FSWYI0014	IN REMOTE	FILTER BACKWASH WASTE PUMP DISCHARGE VALVE IN REMOTE	73-FSW-V-0014	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	No	73-I-001	
931	DI	73FSWZIO0014	OPEN	FILTER BACKWASH WASTE PUMP DISCHARGE VALVE OPENED	73-FSW-V-0014	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN	PLC	No	73-I-001	
932	DI	73FSWZIC0014	CLOSED	FILTER BACKWASH WASTE PUMP DISCHARGE VALVE CLOSED	73-FSW-V-0014	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSED	PLC	No	73-I-001	
933	DO	73FSWUCS0001	START CMD	DISK FILTER START COMMAND	73-FSW-FLT-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	START CMD	N/A	No	73-I-001	
934	DO	73FSWUCS0001	STOP CMD	DISK FILTER STOP COMMAND	73-FSW-FLT-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	STOP CMD	N/A	No	73-I-001	
935	DO	73FSWUCS0002	START CMD	DISK FILTER START COMMAND	73-FSW-FLT-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	START CMD	N/A	No	73-I-001	
936	DO	73FSWUCS0002	STOP CMD	DISK FILTER STOP COMMAND	73-FSW-FLT-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	STOP CMD	N/A	No	73-I-001	
937	DO	73FSWZCO0001	OPEN CMD	DISK FILTER INLET KNIFE GATE OPEN CMD	73-FSW-G-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
938	DO	73FSWZCC0001	CLOSE CMD	DISK FILTER INLET KNIFE GATE CLOSE CMD	73-FSW-G-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
939	DO	73FSWZCO0002	OPEN CMD	FILTER SOLID WASTE PUMP SUCTION VALVE OPEN CMD	73-FSW-V-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
940	DO	73FSWZCC0002	CLOSE CMD	FILTER SOLID WASTE PUMP SUCTION VALVE CLOSE CMD	73-FSW-V-0002	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
941	DO	73FSWZCO0003	OPEN CMD	FILTER BACKWASH WASTE VALVE 0003 OPEN CMD	73-FSW-V-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
942	DO	73FSWZCC0003	CLOSE CMD	FILTER BACKWASH WASTE VALVE 0003 CLOSE CMD	73-FSW-V-0003	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
943	DO	73FSWZCO0004	OPEN CMD	FILTER BACKWASH WASTE VALVE 0004 OPEN CMD	73-FSW-V-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
944	DO	73FSWZCC0004	CLOSE CMD	FILTER BACKWASH WASTE VALVE 0004 CLOSE CMD	73-FSW-V-0004	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
945	DO	73FSWZCO0005	OPEN CMD	FILTER BACKWASH WASTE VALVE 0005 OPEN CMD	73-FSW-V-0005	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
946	DO	73FSWZCC0005	CLOSE CMD	FILTER BACKWASH WASTE VALVE 0005 CLOSE CMD	73-FSW-V-0005	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
947	DO	73FSWZCO0006	OPEN CMD	DISK FILTER RECIRCLATION VALVE OPEN CMD	73-FSW-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
948	DO	73FSWZCC0006	CLOSE CMD	DISK FILTER RECIRCLATION VALVE CLOSE CMD	73-FSW-V-0006	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
949	DO	73FSWZCO0007	OPEN CMD	DISK FILTER SCUM VALVE OPEN CMD	73-FSW-V-0007	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
950	DO	73FSWZCC0007	CLOSE CMD	DISK FILTER SCUM VALVE CLOSE CMD	73-FSW-V-0007	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
951	DO	73FSWZCO0011	OPEN CMD	FILTER SOLIDS WASTE PUMP DISCHARGE VALVE OPEN CMD	73-FSW-V-0011	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
952	DO	73FSWZCC0011	CLOSE CMD	FILTER SOLIDS WASTE PUMP DISCHARGE VALVE CLOSE CMD	73-FSW-V-0011	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
953	DO	73FSWZCO0014	OPEN CMD	FILTER BACKWASH WASTE PUMP DISCHARGE VALVE OPEN CMD	73-FSW-V-0014	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	OPEN CMD	N/A	No	73-I-001	
954	DO	73FSWZCC0014	CLOSE CMD	FILTER BACKWASH WASTE PUMP DISCHARGE VALVE CLOSE CMD	73-FSW-V-0014	72-CTRL-RIO-0001	N/A	N/A	N/A	ETHERNET	CLOSE CMD	N/A	No	73-I-001	
955	AI	81FUEEI0001	VOLTAGE	GENERATOR VOLTAGE	80-GEN-LCP-0001	80-CTRL-PLC-0001	ETHERNET		N/A	N/A	N/A	N/A	No	81-I-001	
956	AI	81FUEII0001	CURRENT	GENERATOR CURRENT	80-GEN-LCP-0001	80-CTRL-PLC-0001	ETHERNET		N/A	N/A	N/A	N/A	No	81-I-001	
957	AI	81FUEJI0001	POWER FACTOR	GENERATOR POWER FACTOR	80-GEN-LCP-0001	80-CTRL-PLC-0001	ETHERNET		N/A	N/A	N/A	N/A	No	81-I-001	
958	AI	81FUEJI0001	KW	GENERATOR KW	80-GEN-LCP-0001	80-CTRL-PLC-0001	ETHERNET		N/A	N/A	N/A	N/A	No	81-I-001	
959	DI	81FUEYA0001	GEN FAIL	GENERATOR FAIL	80-GEN-LCP-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	FAIL	N/A	No	81-I-001	
960	DI	81FUEYIR0001	GEN. RUNNING	GENERATOR RUNNING	80-GEN-LCP-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	RUNNING	N/A	No	81-I-001	
961	DI	81FUEYA0001	GEN BRKR OPENED	GENERATOR BREAKER OPEN	80-GEN-LCP-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	OPEN	N/A	No	81-I-001	
962	DI	81FUEYA0001	GEN BRKR CLOSED	GENERATOR BREAKER CLOSED	80-GEN-LCP-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	CLOSED	N/A	No	81-I-001	
963	DI	81FUEYA0001	BATTERY FAIL	BATTERY FAIL	80-GEN-LCP-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	FAIL	N/A	No	81-I-001	
964	DI	81FUEMAH0002	LEAK DETECTED	GENERATOR FUEL TANK LEAK DETECTED	80-GEN-LSH-0002	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	LEAK DETECTED	N/A	No	81-I-001	
965	DI	81FUELAHH0001	HI-HI LEVEL	GENERATOR FUEL TANK LEVEL HIGH	80-GEN-LSHH-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	LEVEL HIGH	N/A	No	81-I-001	
966	DI	81FUELSL0001	LOW LEVEL	GENERATOR FUEL TANK LEVEL LOW	80-GEN-LSL-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	ETHERNET	LEVEL LOW	N/A	No	81-I-001	
967	DI	81FUEYA0001	ATS FAIL	GENERATOR ATS FAIL	80-GEN-TS-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	81-I-001	
968	DI	81FUEYI0001	GEN. POWER	GENERATOR POWER ON	80-GEN-TS-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	GEN POWER	PLC	No	81-I-001	
969	DI	81FUEUA0001	NORMAL POWER	NORMAL POWER ON	80-GEN-TS-0001	80-CTRL-PLC-0001	N/A	N/A	N/A	24VDC	NORMAL POWER	PLC	No	81-I-001	
970	AI	50ELECAI0001A	PHASE CURRENT	50-ELEC-MCC-0001 PHASE CURRENT	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
971	AI	50ELECAI0001B	PHASE CURRENT	50-ELEC-MCC-0001 PHASE CURRENT	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
972	AI	50ELECAI0001C	PHASE CURRENT	50-ELEC-MCC-0001 PHASE CURRENT	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
973	AI	50ELECAI0001A	PHASE VOLTAGE	50-ELEC-MCC-0001 PHASE VOLTAGE	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
974	AI	50ELECAI0001B	PHASE VOLTAGE	50-ELEC-MCC-0001 PHASE VOLTAGE	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
975	AI	50ELECAI0001C	PHASE VOLTAGE	50-ELEC-MCC-0001 PHASE VOLTAGE	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
976	AI	50ELECAI0001	WATT	50-ELEC-MCC-0001 WATT	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
977	AI	50ELECAI0001	VAR	50-ELEC-MCC-0001 VAR	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
978	AI	50ELECAI0001	POWER FACTOR	50-ELEC-MCC-0001 POWER FACTOR	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
979	AI	50ELECAI0001	WATT HOURS	50-ELEC-MCC-0001 WATT HOURS	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
980	AI	50ELECAI0001	WATT DEMAND	50-ELEC-MCC-0001 WATT DEMAND	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
981	AI	50ELECAI0001	FREQUENCY	50-ELEC-MCC-0001 FREQUENCY	50-ELEC-MCC-0001	50-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
982	AI	80ELECAI0001A	PHASE CURRENT	80-ELEC-SWB-0001 PHASE CURRENT	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
983	AI	80ELECAI0001B	PHASE CURRENT	80-ELEC-SWB-0001 PHASE CURRENT	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
984	AI	80ELECAI0001C	PHASE CURRENT	80-ELEC-SWB-0001 PHASE CURRENT	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
985	AI	80ELECAI0001A	PHASE VOLTAGE	80-ELEC-SWB-0001 PHASE VOLTAGE	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
986	AI	80ELECAI0001B	PHASE VOLTAGE	80-ELEC-SWB-0001 PHASE VOLTAGE	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
987	AI	80ELECAI0001C	PHASE VOLTAGE	80-ELEC-SWB-0001 PHASE VOLTAGE	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
988	AI	80ELECAI0001	WATT	80-ELEC-SWB-0001 WATT	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
989	AI	80ELECAI0001	VAR	80-ELEC-SWB-0001 VAR	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
990	AI	80ELECAI0001	POWER FACTOR	80-ELEC-SWB-0001 POWER FACTOR	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
991	AI	80ELECAI0001	WATT HOURS	80-ELEC-SWB-0001 WATT HOURS	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
992	AI	80ELECAI0001	WATT DEMAND	80-ELEC-SWB-0001 WATT DEMAND	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
993	AI	80ELECAI0001	FREQUENCY	80-ELEC-SWB-0001 FREQUENCY	80-ELEC-SWB-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
994	AI	80ELECAI0001A	PHASE CURRENT	80-ELEC-MCC-0001 PHASE CURRENT	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
995	AI	80ELECAI0001B	PHASE CURRENT	80-ELEC-MCC-0001 PHASE CURRENT	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
996	AI	80ELECAI0001C	PHASE CURRENT	80-ELEC-MCC-0001 PHASE CURRENT	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
997	AI	80ELECAI0001A	PHASE VOLTAGE	80-ELEC-MCC-0001 PHASE VOLTAGE	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
998	AI	80ELECAI0001B	PHASE VOLTAGE	80-ELEC-MCC-0001 PHASE VOLTAGE	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
999	AI	80ELECAI0001C	PHASE VOLTAGE	80-ELEC-MCC-0001 PHASE VOLTAGE	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1000	AI	80ELECAI0001	WATT	80-ELEC-MCC-0001 WATT	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1001	AI	80ELECAI0001	VAR	80-ELEC-MCC-0001 VAR	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1002	AI	80ELECAI0001	POWER FACTOR	80-ELEC-MCC-0001 POWER FACTOR	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1003	AI	80ELECAI0001	WATT HOURS	80-ELEC-MCC-0001 WATT HOURS	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1004	AI	80ELECAI0001	WATT DEMAND	80-ELEC-MCC-0001 WATT DEMAND	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1005	AI	80ELECAI0001	FREQUENCY	80-ELEC-MCC-0001 FREQUENCY	80-ELEC-MCC-0001	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1006	AI	80ELECAI0002A	PHASE CURRENT	80-ELEC-MCC-0002 PHASE CURRENT	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1007	AI	80ELECAI0002B	PHASE CURRENT	80-ELEC-MCC-0002 PHASE CURRENT	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1008	AI	80ELECAI0002C	PHASE CURRENT	80-ELEC-MCC-0002 PHASE CURRENT	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1009	AI	80ELECAI0002A	PHASE VOLTAGE	80-ELEC-MCC-0002 PHASE VOLTAGE	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1010	AI	80ELECAI0002B	PHASE VOLTAGE	80-ELEC-MCC-0002 PHASE VOLTAGE	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1011	AI	80ELECAI0002C	PHASE VOLTAGE	80-ELEC-MCC-0002 PHASE VOLTAGE	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1012	AI	80ELECAI0002	WATT	80-ELEC-MCC-0002 WATT	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1013	AI	80ELECAI0002	VAR	80-ELEC-MCC-0002 VAR	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1014	AI	80ELECAI0002	POWER FACTOR	80-ELEC-MCC-0002 POWER FACTOR	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1015	AI	80ELECAI0002	WATT HOURS	80-ELEC-MCC-0002 WATT HOURS	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1016	AI	80ELECAI0002	WATT DEMAND	80-ELEC-MCC-0002 WATT DEMAND	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	
1017	AI	80ELECAI0002	FREQUENCY	80-ELEC-MCC-0002 FREQUENCY	80-ELEC-MCC-0002	80-CTRL-PLC-0001	N/A		ETHERNET	N/A	N/A	N/A	No	81-I-002	

INPUT/OUTPUT LIST - MORRO BAY WRF

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
1018	AI	90NOCLSI0101	SPEED FEEDBACK	SODIUM HYPOCHLORITE METERING PUMP NO 1 SPEED INDICATION	90-NOCL-LCP-0101	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-001	
1019	AI	90NOCLSI0201	SPEED FEEDBACK	SODIUM HYPOCHLORITE METERING PUMP NO 2 SPEED INDICATION	90-NOCL-LCP-0201	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-001	
1020	AI	90NOCLSI0301	SPEED FEEDBACK	SODIUM HYPOCHLORITE METERING PUMP NO 3 SPEED INDICATION	90-NOCL-LCP-0301	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-001	
1021	AI	90NOCLLI0001	LEVEL	SODIUM HYPOCHLORITE STORAGE TANK LEVEL	90-NOCL-LIT-0001	90-CTRL-RIO-001	4-20mA	0-100% FULL	2-WIRE	N/A	N/A	N/A	No	90-I-001	
1022	AO	90NOCLSC0101	SPEED SETPT	SODIUM HYPOCHLORITE METERING PUMP NO 1 SPEED SET POINT	90-NOCL-LCP-0101	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-001	
1023	AO	90NOCLSC0201	SPEED SETPT	SODIUM HYPOCHLORITE METERING PUMP NO 2 SPEED SET POINT	90-NOCL-LCP-0201	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-001	
1024	AO	90NOCLSC0301	SPEED SETPT	SODIUM HYPOCHLORITE METERING PUMP NO 3 SPEED SET POINT	90-NOCL-LCP-0301	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-001	
1025	DI	90NOCLFAH0001	EYEWASH FLOW	SODIUM HYPOCHLORITE STORAGE AREA EYEWASH ACTIVATED	90-NOCL-FSH-0001	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-001	
1026	DI	90NOCLYIR0101	RUNNING	SODIUM HYPOCHLORITE METERING PUMP NO 1 RUNNING	90-NOCL-LCP-0101	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-001	
1027	DI	90NOCLYA0101	FAIL	SODIUM HYPOCHLORITE METERING PUMP NO 1 FAIL	90-NOCL-LCP-0101	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-001	
1028	DI	90NOCLYI0101	IN REMOTE	SODIUM HYPOCHLORITE METERING PUMP NO 1 IN REMOTE	90-NOCL-LCP-0101	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-001	
1029	DI	90NOCLPAH0101	HI PRESSURE	SODIUM HYPOCHLORITE METERING PUMP NO 1 DISCHARGE HIGH PRESSURE	90-NOCL-LCP-0101	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-001	
1030	DI	90NOCLMAH0101	LEAK DETECTED	SODIUM HYPOCHLORITE METERING PUMP NO 1 LEAK DETECTED	90-NOCL-LCP-0101	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-001	
1031	DI	90NOCLYIR0201	RUNNING	SODIUM HYPOCHLORITE METERING PUMP NO 2 RUNNING	90-NOCL-LCP-0201	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-001	
1032	DI	90NOCLYA0201	FAIL	SODIUM HYPOCHLORITE METERING PUMP NO 2 FAIL	90-NOCL-LCP-0201	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-001	
1033	DI	90NOCLYI0201	IN REMOTE	SODIUM HYPOCHLORITE METERING PUMP NO 2 IN REMOTE	90-NOCL-LCP-0201	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-001	
1034	DI	90NOCLPAH0201	HI PRESSURE	SODIUM HYPOCHLORITE METERING PUMP NO 2 DISCHARGE HIGH PRESSURE	90-NOCL-LCP-0201	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-001	
1035	DI	90NOCLMAH0201	LEAK DETECTED	SODIUM HYPOCHLORITE METERING PUMP NO 2 LEAK DETECTED	90-NOCL-LCP-0201	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-001	
1036	DI	90NOCLYIR0301	RUNNING	SODIUM HYPOCHLORITE METERING PUMP NO 3 RUNNING	90-NOCL-LCP-0301	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-001	
1037	DI	90NOCLYA0301	FAIL	SODIUM HYPOCHLORITE METERING PUMP NO 3 FAIL	90-NOCL-LCP-0301	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-001	
1038	DI	90NOCLYI0301	IN REMOTE	SODIUM HYPOCHLORITE METERING PUMP NO 3 IN REMOTE	90-NOCL-LCP-0301	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-001	
1039	DI	90NOCLPAH0301	HI PRESSURE	SODIUM HYPOCHLORITE METERING PUMP NO 3 DISCHARGE HIGH PRESSURE	90-NOCL-LCP-0301	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-001	
1040	DI	90NOCLMAH0301	LEAK DETECTED	SODIUM HYPOCHLORITE METERING PUMP NO 3 LEAK DETECTED	90-NOCL-LCP-0301	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-001	
1041	DI	90NOCLLAH0002	LEVEL HIGH	SODIUM HYPOCHLORITE STORAGE TANK BUND LEVEL	90-NOCL-LSH-0001	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	HI LEVEL	PLC	No	90-I-001	
1042	DO	90NOCLUCR0101	RUN CMD	SODIUM HYPOCHLORITE METERING PUMP NO 1 RUN COMMAND	90-NOCL-LCP-0101	90-CTRL-RIO-001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-001	
1043	DO	90NOCLUCR0201	RUN CMD	SODIUM HYPOCHLORITE METERING PUMP NO 2 RUN COMMAND	90-NOCL-LCP-0201	90-CTRL-RIO-001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-001	
1044	DO	90NOCLUCR0301	RUN CMD	SODIUM HYPOCHLORITE METERING PUMP NO 3 RUN COMMAND	90-NOCL-LCP-0301	90-CTRL-RIO-001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-001	
1045	DI	90CHEMLAH0001	HI LEVEL	CHEMICAL HAND HOLE - N1 LEVEL HIGH	90-CHEM-LSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEVEL HIGH	PLC	No	90-I-001	
1046	AI	90NOCLSI0401	SPEED FEEDBACK	SODIUM HYPOCHLORITE METERING PUMP NO 4 SPEED INDICATION	90-NOCL-LCP-0401	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1047	AI	90NOCLSI0501	SPEED FEEDBACK	SODIUM HYPOCHLORITE METERING PUMP NO 5 SPEED INDICATION	90-NOCL-LCP-0501	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1048	AI	90NOCLSI0601	SPEED FEEDBACK	SODIUM HYPOCHLORITE METERING PUMP NO 6 SPEED INDICATION	90-NOCL-LCP-0601	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1049	AI	90NOCLSI0701	SPEED FEEDBACK	SODIUM HYPOCHLORITE METERING PUMP NO 7 SPEED INDICATION	90-NOCL-LCP-0701	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1050	AO	90NOCLSC0401	SPEED SETPT	SODIUM HYPOCHLORITE METERING PUMP NO 4 SPEED SET POINT	90-NOCL-LCP-0401	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1051	AO	90NOCLSC0501	SPEED SETPT	SODIUM HYPOCHLORITE METERING PUMP NO 5 SPEED SET POINT	90-NOCL-LCP-0501	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1052	AO	90NOCLSC0601	SPEED SETPT	SODIUM HYPOCHLORITE METERING PUMP NO 6 SPEED SET POINT	90-NOCL-LCP-0601	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1053	AO	90NOCLSC0701	SPEED SETPT	SODIUM HYPOCHLORITE METERING PUMP NO 7 SPEED SET POINT	90-NOCL-LCP-0701	90-CTRL-RIO-001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-002	
1054	DI	90NOCLYIR0401	RUNNING	SODIUM HYPOCHLORITE METERING PUMP NO 4 RUNNING	90-NOCL-LCP-0401	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-002	
1055	DI	90NOCLYA0401	FAIL	SODIUM HYPOCHLORITE METERING PUMP NO 4 FAIL	90-NOCL-LCP-0401	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-002	
1056	DI	90NOCLYI0401	IN REMOTE	SODIUM HYPOCHLORITE METERING PUMP NO 4 IN REMOTE	90-NOCL-LCP-0401	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-002	
1057	DI	90NOCLPAH0401	HI PRESSURE	SODIUM HYPOCHLORITE METERING PUMP NO 4 DISCHARGE HIGH PRESSURE	90-NOCL-LCP-0401	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-002	
1058	DI	90NOCLMAH0401	LEAK DETECTED	SODIUM HYPOCHLORITE METERING PUMP NO 4 LEAK DETECTED	90-NOCL-LCP-0401	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-002	
1059	DI	90NOCLYIR0501	RUNNING	SODIUM HYPOCHLORITE METERING PUMP NO 5 RUNNING	90-NOCL-LCP-0501	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-002	
1060	DI	90NOCLYA0501	FAIL	SODIUM HYPOCHLORITE METERING PUMP NO 5 FAIL	90-NOCL-LCP-0501	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-002	
1061	DI	90NOCLYI0501	IN REMOTE	SODIUM HYPOCHLORITE METERING PUMP NO 5 IN REMOTE	90-NOCL-LCP-0501	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-002	
1062	DI	90NOCLPAH0501	HI PRESSURE	SODIUM HYPOCHLORITE METERING PUMP NO 5 DISCHARGE HIGH PRESSURE	90-NOCL-LCP-0501	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-002	
1063	DI	90NOCLMAH0501	LEAK DETECTED	SODIUM HYPOCHLORITE METERING PUMP NO 5 LEAK DETECTED	90-NOCL-LCP-0501	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-002	
1064	DI	90NOCLYIR0601	RUNNING	SODIUM HYPOCHLORITE METERING PUMP NO 6 RUNNING	90-NOCL-LCP-0601	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-002	
1065	DI	90NOCLYA0601	FAIL	SODIUM HYPOCHLORITE METERING PUMP NO 6 FAIL	90-NOCL-LCP-0601	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-002	
1066	DI	90NOCLYI0601	IN REMOTE	SODIUM HYPOCHLORITE METERING PUMP NO 6 IN REMOTE	90-NOCL-LCP-0601	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-002	
1067	DI	90NOCLPAH0601	HI PRESSURE	SODIUM HYPOCHLORITE METERING PUMP NO 6 DISCHARGE HIGH PRESSURE	90-NOCL-LCP-0601	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-002	
1068	DI	90NOCLMAH0601	LEAK DETECTED	SODIUM HYPOCHLORITE METERING PUMP NO 6 LEAK DETECTED	90-NOCL-LCP-0601	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-002	
1069	DI	90NOCLYIR0701	RUNNING	SODIUM HYPOCHLORITE METERING PUMP NO 7 RUNNING	90-NOCL-LCP-0701	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-002	
1070	DI	90NOCLYA0701	FAIL	SODIUM HYPOCHLORITE METERING PUMP NO 7 FAIL	90-NOCL-LCP-0701	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-002	
1071	DI	90NOCLYI0701	IN REMOTE	SODIUM HYPOCHLORITE METERING PUMP NO 7 IN REMOTE	90-NOCL-LCP-0701	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-002	
1072	DI	90NOCLPAH0701	HI PRESSURE	SODIUM HYPOCHLORITE METERING PUMP NO 7 DISCHARGE HIGH PRESSURE	90-NOCL-LCP-0701	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-002	
1073	DI	90NOCLMAH0701	LEAK DETECTED	SODIUM HYPOCHLORITE METERING PUMP NO 7 LEAK DETECTED	90-NOCL-LCP-0701	90-CTRL-RIO-001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-002	
1074	DO	90NOCLUCR0401	RUN CMD	SODIUM HYPOCHLORITE METERING PUMP NO 4 RUN COMMAND	90-NOCL-LCP-0401	90-CTRL-RIO-001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-002	
1075	DO	90NOCLUCR0501	RUN CMD	SODIUM HYPOCHLORITE METERING PUMP NO 5 RUN COMMAND	90-NOCL-LCP-0501	90-CTRL-RIO-001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-002	
1076	DO	90NOCLUCR0601	RUN CMD	SODIUM HYPOCHLORITE METERING PUMP NO 6 RUN COMMAND	90-NOCL-LCP-0601	90-CTRL-RIO-001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-002	
1077	DO	90NOCLUCR0701	RUN CMD	SODIUM HYPOCHLORITE METERING PUMP NO 7 RUN COMMAND	90-NOCL-LCP-0701	90-CTRL-RIO-001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-002	
1078	AI	90NAOHSI0101	SPEED FEEDBACK	SODIUM HYDROXIDE METERING PUMP NO 1 SPEED INDICATION	90-NAOH-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-003	
1079	AI	90NAOHSI0201	SPEED FEEDBACK	SODIUM HYDROXIDE METERING PUMP NO 2 SPEED INDICATION	90-NAOH-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-003	
1080	AI	90NAOHSI0301	SPEED FEEDBACK	SODIUM HYDROXIDE METERING PUMP NO 3 SPEED INDICATION	90-NAOH-LCP-0301	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-003	
1081	AI	90NAOHLI0001	LEVEL	SODIUM HYDROXIDE STORAGE TANK LEVEL	90-NAOH-LIT-0001	90-CTRL-RIO-0001	4-20mA	0-100% FULL	2-WIRE	N/A	N/A	N/A	No	90-I-003	
1082	AO	90NAOHSC0101	SPEED SETPT	SODIUM HYDROXIDE METERING PUMP NO 1 SPEED SET POINT	90-NAOH-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-003	
1083	AO	90NAOHSC0201	SPEED SETPT	SODIUM HYDROXIDE METERING PUMP NO 2 SPEED SET POINT	90-NAOH-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-003	
1084	AO	90NAOHSC0301	SPEED SETPT	SODIUM HYDROXIDE METERING PUMP NO 3 SPEED SET POINT	90-NAOH-LCP-0301	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-003	
1085	DI	90NAOHFAH0001	EYEWASH FLOW	SODIUM HYDROXIDE AREA EYEWASH FLOW DETECTED	90-NAOH-FSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-003	
1086	DI	90NAOHYIR0101	RUNNING	SODIUM HYDROXIDE METERING PUMP NO 1 RUNNING	90-NAOH-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-003	
1087	DI	90NAOHYA0101	FAIL	SODIUM HYDROXIDE METERING PUMP NO 1 FAIL	90-NAOH-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-003	
1088	DI	90NAOHYI0101	IN REMOTE	SODIUM HYDROXIDE METERING PUMP NO 1 IN REMOTE	90-NAOH-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-003	
1089	DI	90NAOHPAH0101	HI PRESSURE	SODIUM HYDROXIDE METERING PUMP NO 1 HIGH DISCHARGE PRESSURE	90-NAOH-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-003	
1090	DI	90NAOHMAH0101	LEAK DETECTED	SODIUM HYDROXIDE METERING PUMP NO 1 LEAK DETECTED	90-NAOH-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-003	
1091	DI	90NAOHYIR0201	RUNNING	SODIUM HYDROXIDE METERING PUMP NO 2 RUNNING	90-NAOH-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-003	
1092	DI	90NAOHYA0201	FAIL	SODIUM HYDROXIDE METERING PUMP NO 2 FAIL	90-NAOH-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-003	
1093	DI	90NAOHYI0201	IN REMOTE	SODIUM HYDROXIDE METERING PUMP NO 2 IN REMOTE	90-NAOH-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-003	

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
1094	DI	90NAOHPAH0201	HI PRESSURE	SODIUM HYDROXIDE METERING PUMP NO 2 HIGH DISCHARGE PRESSURE	90-NAOH-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-003	
1095	DI	90NAOHMAH0201	LEAK DETECTED	SODIUM HYDROXIDE METERING PUMP NO 2 LEAK DETECTED	90-NAOH-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-003	
1096	DI	90NAOHMAH0301	LEAK DETECTED	SODIUM HYDROXIDE METERING PUMP NO 3 LEAK DETECTED	90-NAOH-LCP-0301	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-003	
1097	DI	90NAOHYIR0301	RUNNING	SODIUM HYDROXIDE METERING PUMP NO 3 RUNNING	90-NAOH-LCP-0301	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-003	
1098	DI	90NAOHYA0301	FAIL	SODIUM HYDROXIDE METERING PUMP NO 3 FAIL	90-NAOH-LCP-0301	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-003	
1099	DI	90NAOHYI0301	IN REMOTE	SODIUM HYDROXIDE METERING PUMP NO 3 IN REMOTE	90-NAOH-LCP-0301	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-003	
1100	DI	90NAOHPAH0301	HI PRESSURE	SODIUM HYDROXIDE METERING PUMP NO 3 HIGH DISCHARGE PRESSURE	90-NAOH-LCP-0301	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-003	
1101	DI	90NAOHLAH0002	LEVEL HIGH	SODIUM HYDROXIDE STORAGE TANK BUND LEVEL HIGH	90-NAOH-LSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI LEVEL	PLC	No	90-I-003	
1102	DO	90NAOHUCR0101	RUN CMD	SODIUM HYDROXIDE METERING PUMP NO 1 RUN COMMAND	90-NAOH-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-003	
1103	DO	90NAOHUCR0201	RUN CMD	SODIUM HYDROXIDE METERING PUMP NO 2 RUN COMMAND	90-NAOH-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-003	
1104	DO	90NAOHUCR0301	RUN CMD	SODIUM HYDROXIDE METERING PUMP NO 3 RUN COMMAND	90-NAOH-LCP-0301	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-003	
1105	AI	90NHSSI0001	SPEED FEEDBACK	SODIUM BISULFITE METERING PUMP NO 1 SPEED INDICATION	90-NHS-LCP-0001	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-004	
1106	AI	90NHSWI0001	WEIGHT	SODIUM BISULFITE STORAGE TOTE NO 1 LEVEL	90-NHS-WIT-0001	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-004	
1107	AI	90NHSWI0002	WEIGHT	SODIUM BISULFITE STORAGE TOTE NO 2 LEVEL	90-NHS-WIT-0002	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-004	
1108	AO	90NHSSC0001	SPEED SETPT	SODIUM BISULFITE METERING PUMP NO 1 SPEED SET POINT	90-NHS-LCP-0001	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-004	
1109	DI	90NHSFAH0001	EYEWASH FLOW	SODIUM BISULFITE STORAGE AREA EYEWASH ACTIVATED	90-NHS-FSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-004	
1110	DI	90NHSYIR0001	RUNNING	SODIUM BISULFITE METERING PUMP NO 1 RUNNING	90-NHS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-004	
1111	DI	90NHSYA0001	FAIL	SODIUM BISULFITE METERING PUMP NO 1 FAIL	90-NHS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-004	
1112	DI	90NHSYI0001	IN REMOTE	SODIUM BISULFITE METERING PUMP NO 1 IN REMOTE	90-NHS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-004	
1113	DI	90NHSPAH0001	HI PRESSURE	SODIUM BISULFITE METERING PUMP NO 1 DISCHARGE HIGH PRESSURE	90-NHS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-004	
1114	DI	90NHSMAH0001	LEAK DETECTED	SODIUM BISULFITE METERING PUMP NO 1 LEAK DETECTED	90-NHS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-004	
1115	DO	90NHSUCR0001	RUN CMD	SODIUM BISULFITE METERING PUMP NO 1 RUN COMMAND	90-NHS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-004	
1116	AI	90NHSSI0002	SPEED FEEDBACK	SODIUM BISULFITE METERING PUMP NO 2 SPEED INDICATION	90-NHS-LCP-0002	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-004	
1117	AO	90NHSSC0002	SPEED SETPT	SODIUM BISULFITE METERING PUMP NO 2 SPEED SET POINT	90-NHS-LCP-0002	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-004	
1118	DI	90NHSYIR0002	RUNNING	SODIUM BISULFITE METERING PUMP NO 2 RUNNING	90-NHS-LCP-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-004	
1119	DI	90NHSYA0002	FAIL	SODIUM BISULFITE METERING PUMP NO 2 FAIL	90-NHS-LCP-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-004	
1120	DI	90NHSYI0002	IN REMOTE	SODIUM BISULFITE METERING PUMP NO 2 IN REMOTE	90-NHS-LCP-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-004	
1121	DI	90NHSPAH0002	HI PRESSURE	SODIUM BISULFITE METERING PUMP NO 2 DISCHARGE HIGH PRESSURE	90-NHS-LCP-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-004	
1122	DI	90NHSMAH0002	LEAK DETECTED	SODIUM BISULFITE METERING PUMP NO 2 LEAK DETECTED	90-NHS-LCP-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-004	
1123	DO	90NHSUCR0002	RUN CMD	SODIUM BISULFITE METERING PUMP NO 2 RUN COMMAND	90-NHS-LCP-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-004	
1124	DI	90CHEMLAH0002	HI LEVEL	CHEMICAL HAND HOLE - S5 LEVEL HIGH	90-CHEM-LSH-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEVEL HIGH	PLC	No	90-I-004	
1125	AI	90ANTISI0001	SPEED FEEDBACK	ANTISCALANT METERING PUMP NO 1 SPEED INDICATION	90-ANTI-LCP-0001	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-005	
1126	AI	90ANTIWI0001	WEIGHT	ANTISCALANT STORAGE TOTE NO 1 LEVEL	90-ANTI-WIT-0001	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-005	
1127	AI	90ANTIWI0002	WEIGHT	ANTISCALANT STORAGE TOTE NO 2 LEVEL	90-ANTI-WIT-0002	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-005	
1128	AO	90ANTISC0001	SPEED SETPT	ANTISCALANT METERING PUMP NO 1 SPEED SET POINT	90-ANTI-LCP-0001	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-005	
1129	DI	90ANTIFAH0001	EYEWASH FLOW	ANTISCALANT STORAGE AREA EYEWASH ACTIVATED	90-ANTI-FSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-005	
1130	DI	90ANTIYIR0001	RUNNING	ANTISCALANT METERING PUMP NO 1 RUNNING	90-ANTI-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-005	
1131	DI	90ANTIYA0001	FAIL	ANTISCALANT METERING PUMP NO 1 FAIL	90-ANTI-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-005	
1132	DI	90ANTIYI0001	IN REMOTE	ANTISCALANT METERING PUMP NO 1 IN REMOTE	90-ANTI-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-005	
1133	DI	90ANTIPAH0001	HI PRESSURE	ANTISCALANT METERING PUMP NO 1 DISCHARGE HIGH PRESSURE	90-ANTI-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-005	
1134	DI	90ANTIMAH0001	LEAK DETECTED	ANTISCALANT METERING PUMP NO 1 LEAK DETECTED	90-ANTI-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-005	
1135	DO	90ANTIUCR0001	RUN CMD	ANTISCALANT METERING PUMP NO 1 RUN COMMAND	90-ANTI-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-005	
1136	AI	90CASI0101	SPEED FEEDBACK	CITRIC ACID METERING PUMP NO 1 SPEED INDICATION	90-CA-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-006	
1137	AI	90CASI0201	SPEED FEEDBACK	CITRIC ACID METERING PUMP NO 2 SPEED INDICATION	90-CA-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-006	
1138	AI	90CAWI0001	WEIGHT	CITRIC ACID STORAGE TOTE NO 1 LEVEL	90-CA-WIT-0001	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-006	
1139	AI	90CAWI0002	WEIGHT	CITRIC ACID STORAGE TOTE NO 2 LEVEL	90-CA-WIT-0002	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-006	
1140	AO	90CASC0101	SPEED SETPT	CITRIC ACID METERING PUMP NO 1 SPEED SET POINT	90-CA-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-006	
1141	AO	90CASC0201	SPEED SETPT	CITRIC ACID METERING PUMP NO 2 SPEED SET POINT	90-CA-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-006	
1142	DI	90CAFAH0001	EYEWASH FLOW	CITRIC ACID STORAGE AREA EYEWASH ACTIVATED	90-CA-FSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-006	
1143	DI	90CAYIR0101	RUNNING	CITRIC ACID METERING PUMP NO 1 RUNNING	90-CA-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-006	
1144	DI	90CAYA0101	FAIL	CITRIC ACID METERING PUMP NO 1 FAIL	90-CA-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-006	
1145	DI	90CAYI0101	IN REMOTE	CITRIC ACID METERING PUMP NO 1 IN REMOTE	90-CA-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-006	
1146	DI	90CAPAH0101	HI PRESSURE	CITRIC ACID METERING PUMP NO 1 DISCHARGE HIGH PRESSURE	90-CA-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-006	
1147	DI	90CAMAH0201	LEAK DETECTED	CITRIC ACID METERING PUMP NO 1 LEAK DETECTED	90-CA-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-006	
1148	DI	90CAYIR0201	RUNNING	CITRIC ACID METERING PUMP NO 2 RUNNING	90-CA-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-006	
1149	DI	90CAYA0201	FAIL	CITRIC ACID METERING PUMP NO 2 FAIL	90-CA-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-006	
1150	DI	90CAYI0201	IN REMOTE	CITRIC ACID METERING PUMP NO 2 IN REMOTE	90-CA-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-006	
1151	DI	90CAPAH0201	HI PRESSURE	CITRIC ACID METERING PUMP NO 2 DISCHARGE HIGH PRESSURE	90-CA-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-006	
1152	DI	90CAMAH0101	LEAK DETECTED	CITRIC ACID METERING PUMP NO 2 LEAK DETECTED	90-CA-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-006	
1153	DO	90CAUCR0101	RUN CMD	CITRIC ACID METERING PUMP NO 1 RUN COMMAND	90-CA-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-006	
1154	DO	90CAUCR0201	RUN CMD	CITRIC ACID METERING PUMP NO 2 RUN COMMAND	90-CA-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-006	
1155	AI	90HSO4NI0101	STROKE LENGTH	SULFURIC ACID METERING PUMP NO 1 STROKE INDICATION	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1156	AI	90HSO4SI0101	SPEED FEEDBACK	SULFURIC ACID METERING PUMP NO 1 SPEED INDICATION	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1157	AI	90HSO4TI020X	TEMP	SULFURIC ACID DILUTION WATER TEMPERATURE	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-120 F	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1158	AI	90HSO4AI020X	COND	SULFURIC ACID DILUTION WATER CONDUCTIVITY	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	90-I-007	
1159	AI	90HSO4TI010X	TEMP	SULFURIC ACID DILUTION WATER TEMPERATURE	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-120 F	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1160	AI	90HSO4AI010X	COND	SULFURIC ACID DILUTION WATER CONDUCTIVITY	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-50 uS/M	4-WIRE	N/A	N/A	N/A	No	90-I-007	
1161	AI	90HSO4NI0201	STROKE LENGTH	SULFURIC ACID METERING PUMP NO 2 STROKE INDICATION	90-HSO4-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1162	AI	90HSO4SI0201	SPEED FEEDBACK	SULFURIC ACID METERING PUMP NO 2 SPEED INDICATION	90-HSO4-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1163	AI	90HSO4WI0001	WEIGHT	SULFURIC ACID STORAGE TOTE NO 1 LEVEL	90-HSO4-WIT-0001	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-007	
1164	AI	90HSO4WI0002	WEIGHT	SULFURIC ACID STORAGE TOTE NO 2 LEVEL	90-HSO4-WIT-0002	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-007	
1165	AO	90HSO4NC0101	STROKE CMD	SULFURIC ACID METERING PUMP NO 1 STROKE SET POINT	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1166	AO	90HSO4SC0101	SPEED SETPT	SULFURIC ACID METERING PUMP NO 1 SPEED SET POINT	90-HSO4-LCP-0101	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1167	AO	90HSO4NC0201	STROKE CMD	SULFURIC ACID METERING PUMP NO 2 STROKE SET POINT	90-HSO4-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1168	AO	90HSO4SC0201	SPEED SETPT	SULFURIC ACID METERING PUMP NO 2 SPEED SET POINT	90-HSO4-LCP-0201	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-007	
1169	DI	90HSO4FAH0001	EYEWASH FLOW	SULFURIC ACID STORAGE AREA EYEWASH ACTIVATED	90-HSO4-FSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-007	

INPUT/OUTPUT LIST - MORRO BAY WRF

Item	IO Type	IO Tag Number	IO Description	Service Description	Field Device	Controller ID	Analog Signal Type	Analog Range	Analog Power Type	Digitial Signal Type	Digital Close State	Digital Power Source	Digital Interp Relay	P&ID Drawing	Remarks
1170	DI	90HSO4PAH0101	HI PRESSURE	SULFURIC ACID METERING PUMP NO 1 DISCHARGE HIGH PRESSURE	90-HSO4-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-007	
1171	DI	90HSO4MAH0101	LEAK DETECTED	SULFURIC ACID METERING PUMP NO 1 HIGH MOISTURE	90-HSO4-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI MOISTURE	PLC	No	90-I-007	
1172	DI	90HSO4YA0101	FAIL	SULFURIC ACID METERING PUMP NO 1 FAIL	90-HSO4-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-007	
1173	DI	90HSO4YI0101	IN REMOTE	SULFURIC ACID METERING PUMP NO 1 IN REMOTE	90-HSO4-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-007	
1174	DI	90HSO4YIR0101	RUNNING	SULFURIC ACID METERING PUMP NO 1 RUNNING	90-HSO4-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-007	
1175	DI	90HSO4PAH0201	HI PRESSURE	SULFURIC ACID METERING PUMP NO 2 DISCHARGE HIGH PRESSURE	90-HSO4-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-007	
1176	DI	90HSO4MAH0201	LEAK DETECTED	SULFURIC ACID METERING PUMP NO 2 HIGH MOISTURE	90-HSO4-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI MOISTURE	PLC	No	90-I-007	
1177	DI	90HSO4YA0201	FAIL	SULFURIC ACID METERING PUMP NO 2 FAIL	90-HSO4-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-007	
1178	DI	90HSO4YI0201	IN REMOTE	SULFURIC ACID METERING PUMP NO 2 IN REMOTE	90-HSO4-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-007	
1179	DI	90HSO4YIR0201	RUNNING	SULFURIC ACID METERING PUMP NO 2 RUNNING	90-HSO4-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-007	
1180	DI	90NPWZIO0001	OPEN	PLANT WATER SUPPLY VALVE NO 1 OPENED	90-NPW-V-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	90-I-007	
1181	DI	90NPWZIC0001	CLOSED	PLANT WATER SUPPLY VALVE NO 1 CLOSED	90-NPW-V-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	90-I-007	
1182	DI	90NPWYI0001	IN REMOTE	PLANT WATER SUPPLY VALVE NO 1 IN REMOTE	90-NPW-V-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-007	
1183	DI	90NPWZIO0002	OPEN	PLANT WATER SUPPLY VALVE NO 2 OPENED	90-NPW-V-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	90-I-007	
1184	DI	90NPWZIC0002	CLOSED	PLANT WATER SUPPLY VALVE NO 2 CLOSED	90-NPW-V-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	90-I-007	
1185	DI	90NPWYI0002	IN REMOTE	PLANT WATER SUPPLY VALVE NO 2 IN REMOTE	90-NPW-V-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-007	
1186	DI	90NPWZIO0003	OPEN	PLANT WATER SUPPLY VALVE NO 3 OPENED	90-NPW-V-0003	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	90-I-007	
1187	DI	90NPWZIC0003	CLOSED	PLANT WATER SUPPLY VALVE NO 3 CLOSED	90-NPW-V-0003	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	90-I-007	
1188	DI	90NPWYI0003	IN REMOTE	PLANT WATER SUPPLY VALVE NO 3 IN REMOTE	90-NPW-V-0003	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-007	
1189	DI	90NPWZIO0004	OPEN	PLANT WATER SUPPLY VALVE NO 4 OPENED	90-NPW-V-0004	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	OPEN	PLC	No	90-I-007	
1190	DI	90NPWZIC0004	CLOSED	PLANT WATER SUPPLY VALVE NO 4 CLOSED	90-NPW-V-0004	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	CLOSED	PLC	No	90-I-007	
1191	DI	90NPWYI0004	IN REMOTE	PLANT WATER SUPPLY VALVE NO 4 IN REMOTE	90-NPW-V-0004	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-007	
1192	DO	90HSO4UCR0101	RUN CMD	SULFURIC ACID METERING PUMP NO 1 RUN COMMAND	90-HSO4-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-007	
1193	DO	90HSO4UCS0101	STOP CMD	SULFURIC ACID METERING PUMP NO 1 STOP COMMAND	90-HSO4-LCP-0101	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	STOP CMD	FIELD	Yes	90-I-007	
1194	DO	90HSO4UCR0201	RUN CMD	SULFURIC ACID METERING PUMP NO 2 RUN COMMAND	90-HSO4-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-007	
1195	DO	90HSO4UCS0201	STOP CMD	SULFURIC ACID METERING PUMP NO 2 STOP COMMAND	90-HSO4-LCP-0201	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	STOP CMD	FIELD	Yes	90-I-007	
1196	DO	90NPWZCO0001	OPEN CMD	PLANT WATER SUPPLY VALVE NO 1 OPEN CMD	90-NPW-V-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	90-I-007	
1197	DO	90NPWZCC0001	CLOSE CMD	PLANT WATER SUPPLY VALVE NO 1 CLOSE CMD	90-NPW-V-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	90-I-007	
1198	DO	90NPWZCO0002	OPEN CMD	PLANT WATER SUPPLY VALVE NO 2 OPEN CMD	90-NPW-V-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	90-I-007	
1199	DO	90NPWZCC0002	CLOSE CMD	PLANT WATER SUPPLY VALVE NO 2 CLOSE CMD	90-NPW-V-0002	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	90-I-007	
1200	DO	90NPWZCO0003	OPEN CMD	PLANT WATER SUPPLY VALVE NO 3 OPEN CMD	90-NPW-V-0003	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	90-I-007	
1201	DO	90NPWZCC0003	CLOSE CMD	PLANT WATER SUPPLY VALVE NO 3 CLOSE CMD	90-NPW-V-0003	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	90-I-007	
1202	DO	90NPWZCO0004	OPEN CMD	PLANT WATER SUPPLY VALVE NO 4 OPEN CMD	90-NPW-V-0004	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	OPEN CMD	FIELD	Yes	90-I-007	
1203	DO	90NPWZCC0004	CLOSE CMD	PLANT WATER SUPPLY VALVE NO 4 CLOSE CMD	90-NPW-V-0004	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	CLOSE CMD	FIELD	Yes	90-I-007	
1204	DI	90POLFFAH0001	EYEWASH FLOW	THICKENING POLYMER STORAGE AREA EYEWASH ACTIVATED	90-POLF-FSH-0001	72-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-008	
1205	AI	90POLFSI0001	SPEED FEEDBACK	THICKENING POLYMER METERING PUMP NO 1 SPEED INDICATION	90-POLF-LCP-0001	72-DWT-LCP-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-008	
1206	AI	90POLFWI0001	WEIGHT	THICKENING POLYMER STORAGE TOTE LEVEL	90-POLF-WIT-0001	72-DWT-LCP-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-008	
1207	AO	90POLFSC0001	SPEED SETPT	THICKENING POLYMER METERING PUMP NO 1 SPEED SET POINT	90-POLF-LCP-0001	72-DWT-LCP-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-008	
1208	DI	90POLFIAH0001	HIGH CURRENT	THICKENING POLYMER STORAGE TOTE AGITATOR CURRENT HIGH	90-POLF-ISH-0001	72-DWT-LCP-0001	N/A	N/A	N/A	24VDC	HI CURRENT	PLC	No	90-I-008	
1209	DI	90POLFYIR0001	RUNNING	THICKENING POLYMER METERING PUMP NO 1 RUNNING	90-POLF-LCP-0001	72-DWT-LCP-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-008	
1210	DI	90POLFYA0001	FAIL	THICKENING POLYMER METERING PUMP NO 1 FAIL	90-POLF-LCP-0001	72-DWT-LCP-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-008	
1211	DI	90POLFYI0001	IN REMOTE	THICKENING POLYMER METERING PUMP NO 1 IN REMOTE	90-POLF-LCP-0001	72-DWT-LCP-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-008	
1212	DI	90POLFMAH0001	LEAK DETECTED	THICKENING POLYMER METERING PUMP NO 1 LEAK DETECTED	90-POLF-LCP-0001	72-DWT-LCP-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-008	
1213	DO	90POLFUCR0001	RUN CMD	THICKENING POLYMER METERING PUMP NO 1 RUN COMMAND	90-POLF-LCP-0001	72-DWT-LCP-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-008	
1214	AI	90LASSI0001	SPEED FEEDBACK	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 SPEED INDICATION	90-LAS-LCP-0001	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-009	
1215	AI	90LASWI0001	WEIGHT	LIQUID AMMONIUM SULFATE STORAGE TOTE NO 1 LEVEL	90-LAS-WIT-0001	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-009	
1216	AI	90LASWI0002	WEIGHT	LIQUID AMMONIUM SULFATE STORAGE TOTE NO 2 LEVEL	90-LAS-WIT-0002	90-CTRL-RIO-0001	4-20mA	0-3,000 LBS	4-WIRE	N/A	N/A	N/A	No	90-I-009	
1217	AO	90LASSC0001	SPEED SETPT	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 SPEED SET POINT	90-LAS-LCP-0001	90-CTRL-RIO-0001	4-20mA	0-100%	2-WIRE	N/A	N/A	N/A	No	90-I-009	
1218	DI	90LASFAH0001	EYEWASH FLOW	LIQUID AMMONIUM SULFATE STORAGE AREA EYEWASH ACTIVATED	90-LAS-FSH-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	EYEWASH ACTIVATED	PLC	No	90-I-009	
1219	DI	90LASYIR0001	RUNNING	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 RUNNING	90-LAS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	90-I-009	
1220	DI	90LASYA0001	FAIL	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 FAIL	90-LAS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	90-I-009	
1221	DI	90LASYI0001	IN REMOTE	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 IN REMOTE	90-LAS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	IN REMOTE	PLC	No	90-I-009	
1222	DI	90LASPAH0001	HI PRESSURE	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 DISCHARGE HIGH PRESSU	90-LAS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	PRESSURE HIGH	PLC	No	90-I-009	
1223	DI	90LASMAH0001	LEAK DETECTED	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 LEAK DETECTED	90-LAS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	LEAK DETECTED	PLC	No	90-I-009	
1224	DO	90LASUCR0001	RUN CMD	LIQUID AMMONIUM SULFATE METERING PUMP NO 1 RUN COMMAND	90-LAS-LCP-0001	90-CTRL-RIO-0001	N/A	N/A	N/A	N/A	RUN CMD	FIELD	Yes	90-I-009	
1225	DI	95SANUA1001	SBPS FAIL	SANITARY PUMP FAIL	95-SAN-LCP-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	FAIL	PLC	No	95-I-001	
1226	DI	95SANLAH1001	SBPS HI LEVEL	SANITARY PUMP STATION HIGH LEVEL	95-SAN-LCP-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	HI LEVEL	PLC	No	95-I-001	
1227	DI	95SANYIR0001	PUMP 1 OR 2 RUNNING	SANITARY PUMP NO 1 OR NO 2 RUNNING	95-SAN-LCP-0001	51-CTRL-RIO-0001	N/A	N/A	N/A	24VDC	RUNNING	PLC	No	95-I-001	

END

Section 40 64 01

VENDOR STANDARD
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 – GENERAL

1-1. SCOPE. This section covers the Equipment Supplier's or Equipment Vendor's standard programmable logic controllers (PLCs) for packaged systems, including associated input/output hardware to control process equipment and serve as the interface to field devices.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all equipment furnished under this section.

1-2. GENERAL. Equipment furnished under this section shall be fabricated, assembled, in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings and equipment specifications indicate the number and types of PLCs, locations of PLCs, who is providing the PLCs and provide diagrams and schematics regarding connection and interaction with other equipment. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the Drawings.

1-2.03. I/O List. An input/output (I/O) field device signal listing is included as an appendix attached to this section.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System, Submittal Procedures, and Schedule of Submittals sections.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System Section.

1-5. SPARE PARTS. The System Supplier shall provide spare parts per the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. GENERAL. All equipment furnished under this section shall be expressly selected by System Supplier for its superior quality for the intended purpose and shall comply with the following requirements.

2-1.01. Initial, Spare, and Future Memory (RAM). System Supplier shall provide adequate memory for the amount of I/O, control algorithms, and communications in the initial system.

2-1.02. Spare I/O. Each PLC input/output enclosure shall be provided with the System Supplier's standard spare inputs and outputs of each type. Spare I/O shall be installed, wired, and interfaced properly to the terminal strip. In addition, each PLC input/output enclosure shall be capable of accommodating the System Supplier's standard additional input/output capacity of each type as originally assembled, without the need for additional expansion racks, communication adapters, cables, or PLC power supplies.

2-1.03. Expandability. Each PLC processor and associated I/O shall have a future expandability based on the System Supplier's standard design for the provided system.

2-1.04. Acceptable Manufacturers. The PLCs shall be the System Supplier's standard product.

2-1.05. Signal Power Supplies. Regulated dc power supplies shall be provided in each PLC enclosure for analog inputs, digital outputs, digital inputs. Output voltage regulation shall be as required by the instrumentation equipment supplied under another section.

The loop power supply shall be separate from the power supply circuit for the processor and racks.

The power source for all digital inputs from field devices shall be separately fused for each digital input module. Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

2-1.06. Appurtenances. The PLC processor and I/O hardware shall be provided as complete systems, as shown on the control system block diagram drawings. The PLCs shall include all necessary hardware and software for a complete working system. All special rack or panel mounted power supplies, special interconnecting and programming cables, special grounding hardware, or isolation devices shall be furnished for proper operation of the equipment. Signal

converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, intrinsically safe relays and current repeaters, surge suppression devices, and isolation devices shall be furnished and installed for proper operation of the equipment.

PLC and RIO panel power supplies shall provide 24-volt dc power for all of the 24-volt dc powered instruments, either loop-powered or 4-wired devices.

2-1.07. PLC Arrangement. The PLCs shall be distributed and arranged as indicated on the Drawings. PLC I/O for duty/standby equipment from separate process trains shall be connected to separate I/O modules.

2-1.08. Service Conditions. PLCs will be installed in air conditioned rooms, non air conditioned rooms or outdoors where the ambient temperature range is 6-22°C. PLCs shall be furnished with sun shades and air conditioned and heated enclosures.

2-2. LARGE PLC PROCESSOR. The programmable logic controller processor shall be the System Supplier's standard industrial-type rack-mounted unit.

2-2.01. Programming Port. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional, and after all communications, human machine interface (HMI), and network connections have been made. Removal or disruption of network communications, remote I/O communications, and HMIs to allow for on-line programming and monitoring will not be acceptable.

2-2.02. Communications. The processor shall be programmed to operate autonomously, regardless of communications status with other units. Each programmable controller shall be furnished complete with communication modules for local and remote input/output hardware communications, communications with other programmable controllers, and communication with host computers as shown on the block diagram. The PLC shall be provided with any required gateway/bridge mux to facilitate seamless Ethernet-based peer-to-peer communication with the Plant Control System's Allen-Bradley ControlLogix and CompactLogix PLCs.

2-2.03. Environment. The processor shall be suitable for operation in the environments specified in another section.

2-2.04. Programming. The processor shall be programmable using EcoStruxure Control Expert the IEC 61131 international programming standards and ladder logic programming. IEC 61131 programming shall include the following:

Functional Block Diagram

Sequential Function Chart.

Instruction List.

Structured Text.

Ladder Diagram.

Ladder logic programming shall include a minimum of the following capabilities:

Contacts, coils, branching.

Data comparisons.

On-delay and off-delay timers.

Counters with comparators.

Floating point Math and Logical instructions.

PID loop control.

Jumps and Subroutine functions.

Master control relay.

Transitional or one-shot outputs.

Standard and user-defined data tables for digital and analog value storage.

Remote I/O capability.

Fault-mode sub-routine.

2-2.05. Programming Capabilities. The processor shall include the following capabilities for programming, debugging of programs, and troubleshooting.

Off-line programming.

On-line programming.

On-line status of coils and registers.

Input/output forcing.

2-2.06. Hardware Configuration. Processors shall be configured for standard rack mounting. Each programmable logic controller processor shall include integral communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces.

2-2.07. Input/Output Hardware. Input/output hardware shall be arranged as indicated on the Drawings. Programmable logic controller systems shall support the following types of input/output modules.

120 volt ac digital input and output.

24 volt dc digital input and output.

4-20 mA dc analog input and output.

Platinum RTD analog input.

All output hardware connected to inductive loads shall be supplied with surge suppression devices and recommended by the PLC manufacturer to prevent damage to output hardware.

2-2.07.01. Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2-2.07.02. I/O Circuit Power Supply. Outputs for motor driven equipment will typically be powered from the driven equipment. Digital outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the Drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate either interposing relays or relay-type digital output modules in the PLC cabinet.

2-2.07.03. Digital Input Modules. Digital input modules shall sense voltages between 100 and 130 volts ac or 20 and 28 volts dc and shall have LED indicators for each point to display the status of the field contact. Return voltage may be common to the entire input module. Digital input modules shall have multiple inputs.

2-2.07-04. Digital Output Modules. Digital output modules shall control voltages from 100 and 130 volts ac or 20 and 28 volts dc. Digital output modules shall have multiple outputs.

2-2.07.05. Relay Digital Output Modules. Where indicated on the PLC input/output listing, digital output modules shall have dry contact relay type outputs suitable to control voltages from 24 to 110 volts dc and 24 to 230 volts ac. Digital outputs for motor driven equipment shall be powered by the driven equipment. Relay digital output modules shall have multiple outputs.

2-2.07.06. Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Analog input modules shall have multiple inputs.

2-2.07.07. Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure. Analog output modules shall have multiple outputs.

2-2.07.08. Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2-2.07.09. Interposing Relays. Interposing relays shall be incorporated on all I/O circuits as shown on the PLC input/output listing, where required by the application of isolate foreign power sources, where the continuous output rating of the PLC relay digital or output module is not sufficient to power the connected device or equipment, or where otherwise required by the System Supplier's equipment. Interposing relays shall be provided for any digital output module output signal that leaves the PLC enclosure. Interposing relays shall be mounted in the PLC enclosure containing the output module that activates the relays.

2-3. MINI PLC PROCESSOR. The programmable logic controller processor shall be the System Supplier's standard industrial type.

2-3.01. Programming Port. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional. Removal or disruption of network communications, remote I/O communications, or HMIs to permit programming and monitoring will not be acceptable.

2-3.02. Communications. The processor shall be programmed to operate autonomously, regardless of communications status with other units. The PLC shall be provided with any required gateway/bridge mux to facilitate seamless Ethernet-based peer-to-peer communication with the Plant Control System's Allen-Bradley ControlLogix and CompactLogix PLCs.

2-3.03. Environment. The processor shall be suitable for operation in the environments specified in another section. A key switch shall be provided on the processor to select the operating mode and as a security measure.

2-3.04. Programming. The processor shall be programmable using conventional relay ladder logic, or as required, and shall include the following functions and features.

Contacts, coils, branching.

Data comparisons.

On-delay and off-delay timers.

Counters with comparators.

Floating Point Math and Logical instructions.

Master control relay.

Transitional or one-shot outputs.

Standard and user-defined data tables for digital and analog value storage.

2-3.05. Capabilities. The processor shall include the following capabilities for programming, debug of programs, and troubleshooting.

Off-line programming.

On-line status of coils and registers.

Input/output forcing.

2-3.06. Configuration. Processors shall be configured for standard rack mounting and shall be of plug-in printed circuit board construction. Each programmable logic controller shall include integral communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces as required.

Programmable logic controller systems shall support the following types of input/output.

120-volt ac digital input and output.

24-volt dc digital input and output.

4-20 mA dc analog input and output.

2-3.07. Input/Output Hardware. Input/output hardware shall be supplied in standard modules of 4, 8, 16, or 32 points each for assembly in local and remote input/output enclosures.

All input/output hardware shall be entirely contained within the PLC enclosure.

All output hardware connected to inductive loads shall be supplied with surge suppression devices as required and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet all of the requirements in the following subparagraphs.

2-3.07.01. Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2-3.07.02. I/O Circuit Power Supply. Outputs for motor driven equipment will typically be powered from the driven equipment. Digital outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the Drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or

shall operate relay-type digital output modules or interposing relays in the PLC cabinet.

2-3.07.03. Digital Input Modules. Digital input modules shall sense voltages between 100 and 130 volts ac or 20 and 28 volts dc and shall have LED indicators for each point to display the status of the field contact.

2-3.07.04. Digital Output Modules. Digital output modules shall control voltages from 100 and 130 volts ac or 20 and 28 volts dc.

2-3.07.05. Relay Digital Output Modules. Where indicated on the PLC input/output listing, digital output modules shall control voltages from 24 to 110 volts dc and 24 to 230 volts ac. Digital outputs for motor driven equipment shall be powered by the driven equipment.

2-3.07.06. Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Input circuitry shall be floating differential type designed to prevent loop grounding. Where analog input signals are grounded outside of the PLC enclosure, isolation shall be provided for the associated analog input point either on the analog input module or through an I/I signal isolator provided in the PLC enclosure.

2-3.07.07. Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure.

2-3.07.08. Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2-4. COMMUNICATIONS. Each programmable controller system shall be furnished complete with communication hardware modules for local input/output hardware, remote input/output hardware, other programmable controllers, or for host computers.

Communication hardware shall be compatible with the cable, data highway or fiber optic communication media. Ethernet components and cable are specified in other specification sections.

2-4.01. Addressability. Each programmable logic controller shall be individually addressable so that only the selected controller responds when queried. IP addressing shall be used. Designation of a controller's network address may be either a software or hardware function.

2-4.02. Communications Hardware. System Supplier shall provide all necessary communications hardware. Hardware shall be included for, but not be limited to, remote I/O, data highway, host computer, fiber optics and Ethernet.

2-4.02.01. PLC to PLC Communications Hardware. Each PLC shall communicate to other PLCs over a network as shown on the control system block diagram. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2-4.02.02. PLC to Remote I/O Communications Hardware. The master PLC shall communicate with the remote PLC rack over a remote I/O communications network. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2-4.02.03. PLC to Host Communications Hardware. Each PLC shall communicate to the host computer over a network as shown on the control system block diagram. System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system. The computer system hardware is covered in another section.

2-4.03. Communications Media. System Supplier shall provide all necessary cabling for the PLC communications network and PLC remote I/O communications network. Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules. PLC communications media shall be as specified under the Network Systems section.

2-5. MEDIA CONVERTERS. Not used.

2-6. TELEPHONE NETWORKS. Not used.

2-7. SERIAL NETWORKS. Not used.

2-8. PROGRAMMING DEVICE HARDWARE. The programming device shall be a portable laptop computer as specified in the Computer System Hardware section. System Supplier shall provide two interconnecting cables to connect the computer to the programmable logic controller. The cables shall be shielded data cable and shall be terminated on both ends with the appropriate connectors. Connectors shall be labeled to identify the connected equipment.

2-8.01. Special Devices. System Supplier shall provide two sets of any special devices (such as null modems, adapter cards, interface converters, etc.) required to establish an operational programming line between the programmable logic controllers and programming device.

2-9. PROGRAMMING SOFTWARE. System Supplier shall furnish one licensed copy of PLC programming software for the Owner and one licensed copy for the Design-Builder. The software shall be suitable for running on a laptop computer running a Windows-based operating system software. A full legal set of programming software documentation shall accompany each copy of the software. Each copy of the programming software shall include all necessary device drivers and add-on software packages.

2-9.01. Standard Product. The programming software shall be personal computer based and a standard product of the PLC manufacturer.

2-9.02. PLC Simulation. Not used.

2-9.03. Programming Software Features. The programming software shall allow off-line development of all PLC-related programming, including user annotation of the program, and creation and printing of application programs and I/O cross-reference lists. Special programming tasks originally provided by System Supplier shall also be included.

On-line features shall include IEC-61131 standards program modification, ladder-logic modification, program language modification, monitoring of real-time ladder-logic execution, monitoring of program execution, monitoring and manipulation of timer and counter preset and present values, monitoring and forcing of physical I/O, and monitoring and manipulation of analog (register) and bit (binary) data table values. PLC and I/O hardware diagnostic and status information shall be accessible using the software in on-line mode.

2-10. SYSTEM ENCLOSURES. Programmable logic controllers and input/output hardware shall be housed in shop-assembled panels as indicated on the Drawings and as described in the Panels, Consoles, and Appurtenances section. Programmable logic controllers and input/output hardware shall be housed in existing panels or panels provided by others.

2-11. OPERATOR INTERFACE TERMINALS. Operator interface terminals (OIT) shall be the System Supplier's standard microprocessor-based flat panel type. The unit shall have data entry capabilities. The unit shall be connected to the PLC and shall display status, alarm, and diagnostic information. The OIT shall be rated NEMA 4X, suitable for panel face.

Terminals shall be suitable for ambient temperatures of +32 to +130°F and a relative humidity of 5 to 95 percent.

One licensed copy of the OIT software used to create the screens shall be turned over to the Owner upon successful startup and commissioning of the system.

The operator interface unit shall be an Eaton PanelMate Power Pro, Allen-Bradley PanelView, or equal.

OIT shall provide graphic screens that shall be used by the operators to access all functions and setpoints necessary for comprehensive control. The equipment vendor supplier shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored and controlled by the control system shall be displayed on the graphic screens. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. The manufacturer shall use the configuration standards and conventions to be established by direct coordination with the Owner that shall describe and define such items as proposed graphic display process line colors/representations; color standards for “on”, “off”, “opened”, “closed”, and “alarm” conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. The Owner utilizes the stop light standard where green is running and open while red is stopped or closed. Proposed displays shall be submitted to the Design-Builder and Owner for approval.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. PLCs installation requirements are specified in Instrumentation and Control System section except as described herein.

Field check, testing, and training shall be as specified in the Instrumentation and Control System section.

3-2. CONFIGURATION.

3-2.01. PLC Programming and Configuration. Configuration services are specified in the Instrumentation and Control System section.

3-2.02. Communications Configuration. The communications shall be fully configured and installed by System Supplier, and shall be operational before application software configuration by others. Communications shall be configured as shown on the Drawings.

End of Section

Section 40 66 11

NETWORK SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. The Network Systems section covers the furnishing of all hardware and software for network systems for the Instrumentation and Control System. Principal components of the network systems shall be as indicated on the block diagram Drawings and as described below.

System Supplier shall furnish all necessary equipment, interconnecting cables, accessories, and appurtenances for proper network operation and to meet the functional requirements indicated on the Drawings and specified herein. Configuration of all hardware shall be provided by the System Supplier.

Equipment and services provided under the Network section shall be subject to the general requirements specified in the Instrumentation and Control System section. Supplementing this section, network data, special requirements, and options may be indicated on the Drawings.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all systems described herein. All applicable requirements specified in the Instrumentation and Control System section shall apply to equipment and services provided herein.

1-1.02. Network Functional Description. The network system shall provide communications between the operator workstations, servers, and PLCs.

1-2. GENERAL. System Supplier shall select the equipment for its superior quality and the intended performance. The System Supplier shall install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the following requirements.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings indicate locations and arrangement of hardware and enclosures, provide mounting details, and may show other information regarding the connection and interaction with other equipment.

1-2.03. Governing Standards. Governing Standards for network systems shall be as specified in the Instrumentation and Control System section.

1-2.04. Power and Instrument Signals. Unless otherwise specified, electric power supply to the network equipment will be unregulated 24 volts dc or 120 volts ac.

1-2.05. Appurtenances. Special power supplies, special cable, special grounding, and isolation devices shall be furnished for proper performance of the equipment.

1-2.06. Interchangeability and Appearance. To the extent possible, components used for similar types of functions and services shall be the same brand and model line. Similar components of different network hardware shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

1-2.07. Programming Devices. A programming or system-configuring device, or software required for programming, shall be provided for systems that contain any equipment that requires such a device or software for routine maintenance and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup. Programming software shall be licensed to the Owner.

1-3. SUBMITTALS. Submittals shall be made in accordance with the requirements of the Instrumentation and Control System section and as listed below.

The submittals shall include the following items for the Network Design submittal (to be provided with the First Stage Submittals):

a. A complete network topology diagram, detailing all hardware, cabling and the interconnections between all connected equipment. Interconnections to existing installed equipment and Owner-furnished equipment shall be included in the diagram.

b. A complete listing of IP addresses to be assigned to all equipment furnished under this contract shall be provided. The assignment of IP addresses shall be coordinated with the Owner.

All above documentation shall also be provided in the O&M manuals.

1-4. DELIVERY, SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

1-5. CONNECTION TO OWNER NETWORKS. Network hardware and software provided shall be compatible with the Owner's existing network systems wherever a system interconnection is provided. System Supplier shall verify existing systems to ensure compatibility.

All connections to the Owner's existing network shall be fully coordinated between the Owner and the System Supplier. Prior to connecting to the existing network, the System Supplier shall provide a written request to the Owner for an Owner's representative to be available when existing systems are disconnected and at the time of any new connections.

1-6. COORDINATION WITH OWNER. The System Supplier shall coordinate all demolitions, installations and rework on the existing networks with the Owner and the Design-Builder. No work shall be performed without the written consent of the Owner. The System Supplier shall submit a written request to perform work on the existing network, including date, time, scope of work, length of time, and any Owner's support that may be required.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum Ethernet network device stipulations.

2-2. NETWORK CABLING SPECIFICATIONS. Individual network equipment and related devices shall be coordinated with items provided in the following sections:

13591 Network Cable

2-3. ETHERNET NETWORK HARDWARE. Ethernet network hardware shall be provided as specified and/or as shown on the Drawings. All specified functionality of provided Ethernet network equipment shall adhere to the IEEE 802 standards. Ethernet Hubs will not be accepted for network systems. Ethernet switches shall be provided to connect multiple network segments together, selectively forwarding traffic between the segments.

2-3.01. Network Ethernet Switches. Each switch shall include the following functionality:

a. Switch shall support the quantity of 10/100/1000BaseTX ports and 10BaseFL/100BaseFX/1000BaseLX Fiber ports to meet the functionality indicated in this specification and as shown on the Drawings. Switches shall have a minimum of 10/100/1000Base-T, RJ-45 ports. A minimum of 20% spare ports shall be provided for the installed system.

b. Each switch connection shall automatically sense the network speed of the devices to which it is connected.

c. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.

d. Prioritization: IEEE 802.1p QoS Support.

e. Support for Optional Redundant Power Supply as required on Drawings.

f. Management: Fully Managed Switch with support for SNMP v.3., and port mirroring.

g. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

h. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 40C.

i. Layer 3

Power over Ethernet (POE) switches shall have the following functionality:

a. Power Enabling and standards: IEEE 812.3af

b. Power: 48 VDC, 50-watt minimum power supply for power enabling switch.

c. LED indication of the link activity for each port and power forwarding.

Switches shall be Cisco “Catalyst Series”, Hewlett Packard “Procurve Switch” series, 3Com “SuperStack II” series, or equal.

2-3.02. Industrial (Panel-Mounted) Ethernet Switches. Each switch mounted in process areas shall include the following functionality:

a. Ports: Switch shall support the quantity of 10/100BaseTX ports and 100BaseFX fiber ports to meet the functionality indicated on the Drawings, with a minimum of 20% spare auto-negotiating 10/100Base-T, RJ-45 ports, and two multimode fiber uplink ports. A minimum of four UTP ports shall be provided.

b. Each switch connection shall automatically sense the network speed of the devices to which it is connected.

c. Capable of ring-based media redundancy with 30 ms recovery time.

d. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.

e. Prioritization: IEEE 802.1p QoS Support.

f. Network Segregation: Port VLAN.

g. Management: SNMPv3 and Browser-based management shall be supported.

h. IGMP snooping supported.

i. LED indication of the link activity for each port.

j. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 60C. Optional -40 to 60C rating availability.

k. Redundant 24 VDC power supply inputs

l. Conformal coating option for use in hazardous environments.

m. Mounting: DIN-rail mounted suitable for panel installation.

n. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

o. Layer 2 or 3

Power over Ethernet (POE) switches shall have the following functionality:

a. Power Enabling and standards: IEEE 812.3af

b. Power: 48 VDC, 50-watt minimum power supply for power enabling switch.

c. LED indication of the link activity for each port and power forwarding.

Switches shall be GarretCom Magnum 6K Series, Hirschmann RS-20 series, Moxa 508A series, N-Tron 708FX series, SIXNET SL-8MG Series. With POE Injector, or equal.

2-3.03. Network Routers. Routers shall be provided to allow connection of a Wide Area Network (WAN) to the Local Area Network (LAN). These routers shall provide the flexibility to adapt to changing requirements, features and performance to support new WAN services, and integration of multiple network functions to simplify deployment and management operations.

a. LAN Connection: 10/100 Base-T Ethernet Port

b. WAN Connection: At least 2 CSU slots. Provide CSU for a T1 interface to enable direct connection to the phone company network

c. Management: Browser based, and SNMP v2 or v3.

d. IEEE 802.1p QoS Support.

e. Router Redundancy Functionality (HSRP, VRRP, etc.) where required to meet the specified functionality.

f. VLAN Support

g. Rack mounting, where required for proper installation.

Routers shall be Cisco 1800 series Modular Access Routers, 3Com 5000 series Routers, Hewlett Packard ProCurve Routing Switches, or equal.

2-3.04. Network Firewall. Network firewall hardware shall be a dedicated hardware device and provide security and isolation between networks. Firewalls shall have the following functionality:

a. Stateful Packet Inspection and Filtering.

b. DHCP and Network Address Translation Services.

c. Virtual private networking (VPN) support.

d. A minimum of three dedicated or configurable DMZ port.

e. A minimum of five integrated 10/100Base-T ports.

f. Management: Browser based, and SNMP v2 or v3.

g. Logging of all access through the firewall.

h. Rack mounting, where required for proper installation.

Firewalls shall be Cisco ASA 5505 series, or equal. Firewall capability can be provided with a router, provided the above functionality is provided.

2-3.05. Ethernet Connectors. Ethernet wiring connectors shall be RJ-45 male modular plug connectors.

2-3.05.01. Standard RJ45 Connectors. Standard connectors shall be polycarbonate, clear connectors. Connectors shall conform to RJ-45 and ISO 8877 standards. Contacts shall be gold plated with a 0.5A current rating and a -25º to 60º C temperature rating. Connectors shall accept unshielded Cat-5e or Cat-6, AWG 24, solid conductor cable.

2-3.05.02. Industrial RJ45 Connectors. Not used.

2-3.06. Media Converters. Not used.

2-3.07. Frame Relay Routers. Not used.

2-4. ETHERNET NETWORK SOFTWARE. All switches and routers shall be managed from a graphical user interface on a Microsoft Windows operating system computer. Network management software and all network equipment provided by the System Supplier shall be compatible with each other, allowing management of each device from the provided software. Network management

software shall be the latest version of Cisco Netmanager IP Infrastructure, or equal.

2-3. SPARE PARTS. The System Supplier shall provide spare parts per the general Terms and Conditions.

PART 3 - EXECUTION

3-1. NETWORK INSTALLATION REQUIREMENTS. Additional network installation requirements are specified in the Instrumentation and Control System section. Networks shall be installed and tested in accordance with the following requirements.

3-2. NETWORK CONFIGURATION. The System Supplier shall fully configure all network devices. All device selections shall be fully coordinated with the Owner to ensure compatibility with existing systems and standards.

3-2.01. Ethernet Switches. The System Supplier shall fully configure all Ethernet switches. The following shall be configured:

a. Unused ports shall be disabled for security purposes.

b. Spanning Tree or other appropriate redundancy scheme shall be configured for all redundant links. Trunking or other bandwidth sharing redundancy schemes shall be utilized where available to minimize switching times and increase available bandwidth.

c. Management Password Security

d. Quality of Service, with any traffic to/from PLCs getting priority over all other traffic.

3-2.02. Routers. The System Supplier shall fully configure all network routers. The routers shall be configured for all network and telephone interfaces.

3-2.03. Firewalls. The System Supplier shall fully configure all network firewalls. The firewall shall be configured for all network connections provided under this contract and shall be configured to exclude devices not part of the control system network unless otherwise specified. The firewall shall be configured to deny all traffic, except for traffic specifically allowed in the ruleset.

3-2.04. Network Configuration Report. The System Supplier shall provide a configuration report to the Owner detailing all connections, addresses, and port assignments

3-2.05. Management Software. Management software shall be fully configured for all network devices provided.

3-3. NETWORK TESTING. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test.

3-3.01. Field Testing. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test. Specific testing requirements are described in the individual network specification sections.

3-3.02. Systems Check. A technical representative of System Supplier shall participate in the checkout of network systems. Systems check requirements shall be as specified in the Instrumentation and Control System section.

3-3.02.01. Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

3-3.02.02. Ethernet Network Minimum Test Requirements. The following minimum tests are to be performed by the System Supplier:

a. Verify Link Integrity Status LED is lit on both sides of each link.
b. Verify proper operation and failover of each redundant component and redundant link.
c. Verify alarming of each link failure.
d. Verify bandwidth Usage.

3-3.02.03. Ethernet Network Test Reports. Upon completion and testing of the installed Ethernet network, the System Supplier shall submit test reports to the Engineer in printed form. Test reports are to show all test results performed by the System Supplier for each port and piece of equipment. Date of calibration of the test equipment is also to be provided.

3-4. NETWORK TROUBLESHOOTING. It is the System Supplier's responsibility to provide trouble-free and reliable networks. The System Supplier shall employ any means necessary to ensure operational networks. The System Supplier shall obtain any needed test equipment, including but not limited to time-domain reflectometers, protocol analyzers and network sniffers, to troubleshoot any problems. The System Supplier shall utilize the services of a trained and certified Network Engineer that is regularly involved in troubleshooting network problems, in the event that operational or reliability problems exist. Acceptable

certifications include Cisco CCNP, Cisco CCIE, or Network Professional Association Certified Network Professional (CNP).

3-5. CUSTOMER TRAINING. Training for networks is covered under Network Training in the Instrumentation and Control System section and the Demonstration and Training section.

End of Section

Section 40 66 33

METALLIC AND FIBER OPTIC COMMUNICATION CABLE AND CONNECTORS

PART 1 - GENERAL

1-1. SCOPE. The Metallic and Fiber Optic Communications Cable and Connectors section covers the furnishing and installation of cable systems to provide communications for the Instrumentation and Control System as indicated on the Drawings.

Accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.

Equipment and services provided under this section shall be subject to the General Computer Control System Requirements specified in the Instrumentation and Control System section and the Network Systems section. Supplementing the Metallic and Fiber Optic Communications Cable and Connectors section, network data, special requirements, and options are indicated on the Drawings.

1-2. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

1-2.01. Qualifications. The name, address and telephone number of the proposed subcontractor, including specific personnel to perform the work shall be included with the submittals. Provide the experience record of the subcontractor and personnel in performing work similar to that specified. Include the agency, contact person, and telephone number of at least three (3) previous network installation projects completed by the proposed subcontractor. The Design-Builder shall review and approve the network installation subcontractor and personnel prior to any of the related work being performed. This review will be conducted during the project submittal phase, as described below.

1-2.02. Drawings and Data. All material and equipment documentation shall be submitted for review in accordance with the Submittals section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment.

Product data shall include the following in the Submittals section:

a. Cut sheets and catalog literature for proposed fiber optic cable, and fiber optic cable accessories (pigtails, connectors, etc.).

b. Manufacturer specifications and data that clearly shows that the fiber optic cable meets all requirement specified herein.

c. Sample of the proposed cable.

d. Physical dimension drawings of all fiber optic accessories.

e. Proposed fiber identification sequence and labeling.

f. Provide off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.

g. Provide a Recommended Spare Parts List (RSPL).

h. Provide a list of recommended special tools for fiber installation testing or maintenance.

1-2.03. Operations and Maintenance Manuals. Operation and Maintenance Manuals shall have the following items included in addition to those items specified in other sections:

a. Description of all components.

b. Methods of connection.

c. Connection diagram.

d. OTDR trace plots for all fibers.

1-3. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section.

1-4. QUALIFICATIONS. Due to the specialized nature of installing, splicing, terminating, and testing optical fiber cable, the subcontractor shall utilize personnel who are experienced in such practices. The installing subcontractor or Subcontractor shall have performed similar installation and testing work on at least three projects of similar size and complexity. The personnel assigned to the installation and testing shall also have experience on at least three projects of similar size and complexity.

PART 2 - PRODUCTS

2-1. GENERAL. All fiber optic cable, fiber optic hardware and accessories shall be designed, assembled and connected in accordance with the requirements of these Specifications and the Drawings.

2-2. ETHERNET UNSHIELDED TWISTED PAIR (UTP) CABLE. Ethernet cables and connectors shall be provided for a complete and working system, and/or as shown on the Drawings. Cable for Ethernet wiring shall be UTP Cat-6 cable. Jacket color coding for cables shall be as follows:

a. Standard Cat-6. Yellow
b. Crossover cables. Red

Cable shall meet the following characteristics:

2-2.01. Category 5e UTP Cable. Not used.

2-2.02. Category 6 UTP Cable. Cat-6 cable shall meet the following requirements:

a. 24 AWG
b. 4 pair solid strand FEP Teflon insulation
c. 100 Ohm impedance
d. 1-250 MHz frequency range
e. Min attenuation 19.9 Db
f. 100 Ohm impedance
g. Min NEXT 44.3dB/100MHz
h. Min PS-NEXT 42.3dB/100MHz
i. Min ELFEXT 27.8dB/100MHz
j. Min PS-ELFEXT 24.8dB/100MHz
k. Min return loss 20.1 dB/100 MHz
l. Max delay skew 45 ns
m. Max propagation delay 540 ns

Plenum rated cable shall have FEP insulation jacketing and FEP insulation for conductors. Non plenum rated cable shall have PVC insulation jacketing and polyethylene insulation for conductors. Cat-6 cable shall be Belden 1872 or equal.

2-2.03. Ethernet Patch Cables. Pre-wired and terminated patch cables with RJ-45 connectors and lever protecting boot shall be furnished for all connections to computers, network equipment, and controller equipment except where physical conditions (i.e. length over 12 ft. or conduit size) require unterminated wire to be installed. Patch cables shall meet the requirements of Cat-6 cable specified in

this section. Straight through cables shall be wired using the T568-B standard for both connectors as shown in section 3-1.01. Crossover cables shall be wired using the T568-A standard for one connector and the T568-B standard for the opposite end.

2-3. FIBER OPTIC CABLE. The fiber optic cable must meet all of the requirements of the following paragraphs.

a. The fiber optic cable must meet the following requirements of the National Electrical Code (NEC) Section 770.

b. Riser Applications – Applicable Flame Test UL 1666.

c. Finished cables shall conform to the applicable performance requirements of Table 8-6 and 8-7 in the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Fiber Optic Premises Distribution Cable (ICEA S-83-596).

d. Every fiber in the cable must be usable and meet required specifications.

e. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

f. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

g. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.

h. All optical fibers shall be 100 percent attenuation tested. The attenuation shall be measured at 850 nm, and 1300 nm for multimode fibers. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of 5 years. These values shall be available upon request.

i. The storage temperature range for the cable on the original shipping reel shall be –40°C to +70°C. The operating temperature range shall be –40°C to +70°C. Testing shall be in accordance with FOTP-3.

j. The attenuation specification shall be a maximum attenuation for each fiber at 23 $\pm$ 5°C.

k. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB at 850 nm/1300 nm (multimode) in any one-kilometer length of fiber.

l. Required Fiber Grade: Maximum Fiber Attenuation at 850 nm shall be 3.5 dB/km.

m. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm.

n. The cable shall contain 24 fibers. Each buffer tube shall contain up to 12 fibers.

o. The fibers shall not adhere to the inside of the buffer tube.

p. Each fiber shall be distinguishable from others by means of color coding in accordance with TIA/EIA-598-A, “Optical Fiber Cable Color Coding.”

q. The fibers shall be colored with ultraviolet (UV) curable inks.

r. Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-A, “Optical Fiber Cable Color Coding.”

s. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

t. The buffer tubes shall be resistant to kinking.

u. The cable jacket color shall be black.

v. Fibers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fibers shall be placed so that they do not interrupt the consecutive positions of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 3.0 nm in outer diameter.

w. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

x. The outer cable jacket shall be marked with the manufacturer’s name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet (e.g. “62.5/125 MICRON – TYPE OFNR – (UL) 00001 Feet”). The print color shall be white.

y. The cable shall be all-dielectric.

z. The cable shall be gel-free.

aa. Flammability – All cables shall comply with the requirements of the 1996 NEC Article 770. All cables shall pass UL 1666.

Fiber optic cable shall be as manufactured by Corning Cable Systems, Belden, Commscope, TE Connectivity, or equal.

2-3.01. Multimode Fiber. Multimode fiber shall be 62.5/125µm core diameter or 50/125 µm core diameter cable.

62.5 µm core diameter multimode fiber optic cable shall meet the following requirements:

a. The multimode fiber utilized in the cable specified herein shall meet EIA/TIA-492AAAA-1989, “Detail Specification for 62.5 m Core Diameter/125 m Cladding Diameter Class Ia Multimode, Graded Index Optical Waveguide Fibers.”
b. Core diameter: 62.5 ± 3.0 micrometers.
c. Cladding diameter: 125.0 ± 2.0 micrometers.
d. Core-to-Cladding Offset: ≤ 3.0 micrometers.
e. Cladding non-circularity: ≤ 2.0%. Defined as: [1-(min. cladding dia. + max. cladding dia.)] X 100.
f. Core non-circularity: ≤ 6.0%. Defined as: [1-(min. core dia. + max. core dia.)] X 100.
g. Coating Diameter: 245 ± 10 micrometers.
h. Graded index.
i. Numerical Aperture: 0.275 ± 0.015.
j. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.
k. Minimum Bandwidth Requirement shall be 160/500 MHz-km at 850/1300 nm.

50 µm core diameter multimode fiber optic cable shall meet the following requirements:

a. The multimode fiber utilized in the cable specified herein shall meet EIA/TIA-492AAAA-1989, “Detail Specification for 50 m Core Diameter/125 m Cladding Diameter Class Ia Multimode, Graded Index Optical Waveguide Fibers.”
b. Core diameter: 50 ± 3.0 micrometers.
c. Cladding diameter: 125.0 ± 2.0 micrometers.
d. Core-to-Cladding Offset: ≤ 3.0 micrometers.

e. Cladding non-circularity: ≤ 2.0%. Defined as: [1-(min. cladding dia. + max. cladding dia.)] X 100.

f. Core non-circularity: ≤ 6.0%. Defined as: [1-(min. core dia. + max. core dia.)] X 100.

g. Coating Diameter: 245 ± 10 micrometers.

h. Graded index.

i. Numerical Aperture: 0.275 ± 0.015.

j. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.

k. Minimum Bandwidth Requirement shall be 500/500 MHz-km at 850/1300 nm.

2-3.02. Singlemode Fiber. Singlemode fiber optic cable shall meet the following requirements:

a. The dispersion unshifted single-mode fiber utilized in the cable specified herein shall conform to the specifications herein.

b. Cladding Diameter: 125.0 + 1.0 μm.

c. Core-to-Cladding Offset: < 0.8 μm.

d. Cladding Non-Circuladty: < 1.0%.

e. Coating Diameter: 245 ± 10 μm.

f. Colored Fiber Diameter: nominal 900 μm.

g. Attenuation Uniformity: No point discontinuity greater than 0. 1 0 dB at either 1310 nm or 1550 nm.

h. Attenuation at the Water Peak: The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km.

i. Cutoff Wavelength: The cabled fiber cutoff wavelength(λccf,) shall be < 1260 nm.

j. Mode-Field Diameter: 9.30±0.50 μm at 1310 nm 10.50 ± 1.00 micrometers at 1550 nm.

k. Zero Dispersion Wavelength (λo): 1301.5 nm < λo < 1321.5 nm.

l. Zero Dispersion Slope (So): < 0.092 ps/(nm^2 *km).

m. Fiber Polarization Mode Dispersion (PMD): < 0.5 ps/(sq. km).

2-3.03. Fiber optic cable connectors. All optical fibers shall be terminated with connectors that are type ST for multimode cable and type SC for singlemode cable.

2-3.03.01. Epoxy Connectors. Epoxy connectors shall be provided to terminate each fiber in the cable. Connector style, ST, SC, or other, shall be coordinated with the patch panels and field devices that will interface directly with the cable. Connectors shall be compatible with the supplied cable. Connector loss shall be no greater than 0.3 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each termination. Connectors shall be Corning Cable Systems Connectors, or equal.

2-3.03.02. Crimp Style Connectors. Not used.

2-3.04. Fiber Optic Jumper Cables. Fiber optic jumper cables shall be furnished and installed for equipment interfacing and between termination cabinets. The jumpers shall meet the following requirements:

a. The jumpers shall be 62.5/ 125 microns50/ 125 microns, multimode for operation at 1300 nm. They shall be tight-buffered and be protected by Kevlar-type strength material.

b. The jumpers shall be supplied with connectors on each end. Connector types (ST, SC, LC, etc.) shall be matched to the equipment provided. Jumpers shall be sized to provide a single connection between the fiber optic hardware being connected.

2-4. PLC COMMUNICATIONS MEDIA. Not used.

2-5. INDUSTRIAL COMMUNICATIONS CABLING. Not used.

2-6. ETHERNET CABLE TEST EQUIPMENT. One hand-held network cable tester that is compatible with the provided network cabling shall be provided. The cable tester shall check for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs for faults up to 100 m. Tester shall be Black Box "Model SOHO Plus Tester", Fluke MicroScanner2 Pro, or equal.

PART 3 - EXECUTION

3-1. INSTALLATION. The System Supplier shall be responsible for the coordination of the installation of all cable furnished hereunder. The System Supplier shall be responsible for the termination of all cable furnished hereunder.

3-1.01. Cable Damage. If the cable becomes damaged during installation, the subcontractor shall stop work and notify the Design-Builder immediately. The Owner and Design-Builder will decide whether to replace the entire reel of cable or to install a splice at the damaged section. If the Owner decides to replace the entire reel of cable, the subcontractor shall begin the installation at the last

designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the Owner. Installation of new cable to replace damaged cable shall not be a basis of extra payment or contract completion time. In addition to installation of the new cable, the subcontractor shall reimburse the Owner for the entire cost of the replacement reel of cable. This cost will be withheld from the contract price. If the Owner decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at the subcontractor's expense.

3-1.02. Ethernet Cable Installation. Straight through cables shall be wired using the T568-B standard for both connectors as shown in the table below (connector pin numbers are left to right with the clip down). Crossover cables shall be wired using the T568-A standard for one connector and the T568B standard for the opposite end as shown in the table below.

Connector Pin	568A Wiring Conductor	568B Wiring Conductor
1 2	White/Green Green	White/Orange Orange
3 6	White/Orange Orange	White/Green Green
4 5	Blue White/Blue	Blue White/Blue
7 8	White/Brown Brown	White/Brown Brown

3-1.03. Fiber Optic Cable Installation. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification. Fiber optic cable installation shall meet the following requirements:

a. All fiber optic cable shall be installed, terminated, and tested by the System Supplier or his fiber subcontractor as specified above.

b. In pulling the cable, strain-release, or other tension limiting devices shall be used to limit the pull tension to less than 600 lbs.

c. Minimum bend radius restrictions shall be satisfied both during and after cable installation.

d. Horizontal, unsupported cable runs shall be supported at continuous distances of 5 feet or less.

e. All conduit and cabinet entrances shall be sealed with RTV or other re-enterable sealant material to prevent ingress of water, dust or other foreign materials.

f. Cable routing within occupied office areas shall conform to Federal, State, and local electrical and fire codes.

g. Any non-terminating (field) splices shall be documented as to the physical location and cable meter mark (prior to stripping). Field splices shall be OTDR-tested and documented prior to final cable acceptance testing.

h. Fiber optic cables shall be installed in accordance with NECA 301-2004, Installing and Testing Fiber Optic Cables.

3-2. CABLE TESTING. After the network cabling has been installed, each network cable shall be tested.

3-2.01. Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

3-2.02. Ethernet UTP Cable Testing. The System Supplier shall utilize the previously specified test equipment, and additional tools as needed to validate the Ethernet UTP cable installation. All test equipment shall bear current calibration certification from a certified calibration laboratory, as appropriate. Each cable shall be tested for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs. A check off sheet shall be utilized, shall be signed by the technician testing the cables, and shall be submitted for approval. Any identified faults shall be corrected at no additional cost.

3-2.03. Fiber Optic Cable Testing. Acceptance testing of the data highway (fiber and electronic equipment) shall be conducted as a part of integrated system field testing, as specified elsewhere. Prior to such tests, however, the fiber optic cable shall be tested as specified herein.

The System Supplier, or his fiber subcontractor, shall conduct fiber optic cable testing as specified below. All testing following field installation shall be witnessed by the Design-Builder. The subcontractor shall bear the cost for field witnessed testing in accordance with Section 01610, General Equipment Stipulations. A test plan shall be submitted prior to the proposed test dates. The test plan and procedures shall be mutually agreed to prior to conducting the tests.

Each optical fiber of each fiber optic cable shall be OTDR (Optical Time Domain Reflectometer) tested on the reel at the factory, on the reel upon arrival at the jobsite, and after installation and termination. For each fiber, an OTDR (Optical Time Domain Reflectometer) trace soft/hardcopy is required to be provided to the Owner and Design-Builder. OTDR traces shall be provided for each test (at the

factory, on the reel at the job-site, and after installation). A 100-foot launch cable shall be spliced to each fiber for each fiber OTDR test, to ensure accurate results. This end-to-end trace shall be performed from BOTH ends of the fiber. Also, for each fiber, an end-to-end power attenuation (insertion loss) test shall be performed. The attenuation test shall use a stabilized optical source and an optical power meter calibrated to the appropriate operating wavelength (1300 nm).

For each installed fiber, the power attenuation shall not exceed the following, tested from connector to connector at the respective patch panels:

(0.0035)L + (0.25)N + 3.0 dB

Where L = The length of the fiber optic cable in meters and
N = the number of splices in the fiber.

Any fiber optic cables containing one or more fibers not meeting this performance will not be accepted by the Owner and shall be repaired or replaced at no additional cost.

Each fiber optic jumper cable shall be tested and must exhibit an end-to-end attenuation of less than 2.0 dB at 1300 nm. Any jumper exceeding this level shall be replaced at no additional cost to the owner. Any damaged cable still on the reel shall be returned to the manufacturer for replacement at no additional cost to the Owner.

All fiber cable testing shall be documented on pre-approved test forms. Three (3) copies of all documentation (including OTDR traces) shall be submitted to the Design-Builder upon successful completion of the testing.

End of Section

Section 40 67 11

PANELS, CONSOLES, AND APPURTENANCES

PART 1 - GENERAL

1-1. SCOPE. The Panels, Consoles and Appurtenances section covers the furnishing of panels, consoles, and appurtenances as indicated on the Drawings.

This section also describes requirements for panels furnished under other sections whose respective specification refers to this section. Panels furnished under other sections are not listed in the attached Equipment Schedules.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all equipment furnished under the Panels, Consoles and Appurtenances section.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated and assembled in full conformity with the Drawings, specifications, equipment schedules, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Drawings. General dimensions and arrangements are indicated on the Drawings and on the attached equipment schedules. System Supplier shall be responsible for coordinating the console and enclosure sizes and arrangements to accommodate the equipment provided.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System, Submittal Procedures, and Schedule of Submittals sections.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as per The Instrumentation and Control System section.

1-5. SPARE PARTS. The System Supplier shall provide spare parts per the general Terms and Conditions.

PART 2 - PRODUCTS.

2-1. PANEL DESIGN AND FABRICATION FEATURES. All panels furnished shall conform to the stipulations of NEMA ICS-6-1993 (R2001, R2006). Unless indicated otherwise on the Drawings, the following paragraphs describe general fabrication specifications for the PLC cabinets, instrument panels, consoles, enclosures, and subpanels.

2-1.01. Piping. Pneumatic tubing shall be 1/4-inch OD, soft annealed copper with compression fittings. Tubing and fittings shall be as specified in the Miscellaneous Piping section.

2-1.01.01. Fittings. Compression type bulkhead fittings shall be provided near the bottom or the top of the panel for all field connections. Compression nuts and sleeves shall be provided for the field connections. Indicators, recorders, controllers, and other pneumatic devices shall be provided with plugged test connections and shutoff valves for isolation.

2-1.01.02. Valves. All devices shall have separate air supply shutoff valves. Valves and compression fittings shall be as manufactured by Nupro, Parker Hannifin, Swagelock, Tylok, or Whitey.

2-1.02. Power Entrance. The power entrance to each panel shall be provided with a surge protection device. Refer to the Instrumentation and Controls section for surge suppression requirements.

2-1.03. Power Wiring. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 14 AWG. Wiring for ac power distribution, dc power distribution, intrinsically safe, and control circuits shall have different colors and shall agree with the color-coding legend on System Supplier's panel wiring diagrams. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame retardant covering rated for not less than 90°C.

2-1.04. Instrument and Control Wiring. All internal panel wiring shall be type MTW stranded copper wiring rated not less than 600 volts. Electronic analog circuits shall be twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Intrinsically safe circuits shall be physically separated from other circuits in accordance with applicable codes.

Wires within the panel shall conform to the minimum size as shown in the table below.

Type	Min. Wire Size	Color
AC Control	16 AWG	Red
DC Control	16 AWG	Blue
Analog Circuits	18 AWG Twisted Pair	Yellow

All wiring shall be grouped or cabled and firmly supported inside the panel. Each individual wire in power, control, and instrumentation circuits shall be provided with identification markers at each point of termination. The wire markers shall be positioned to be readily visible for inspection and the identification numbers shall match the identification on the supplier's panel wiring drawings. Wiring shall be bundled in groups and bound with nylon cable ties or routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and with space equal to at least 40 percent of the depth of the duct remaining available for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

2-1.05. Terminal Blocks. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

2-1.06. Backup Power. Power supply to the panels shall be from electrical sources shown on the Drawings, which may be backed by redundant utility feeds, engine generators, or externally mounted uninterruptible power supplies (UPSs) specified in other sections.

Where indicated in the attached equipment schedules, on the Drawings or in the referring equipment specifications, free-standing vertical panels and wall cabinets shall each be provided with an interior-mounted UPS to provide backup power to critical loads upon loss of power supply to the panel. UPS-backed power shall be provided to the programmable logic controller CPU, instrument loops, I/O modules (operating and wetting voltages), all network communications devices, and any other load essential to preventing loss of control system function. Backup power for panel interior lights, heaters, and convenience receptacles is

not required. UPSs for free-standing vertical panels and wall cabinets shall meet the requirements specified below.

Where required within the respective enclosure specification or shown on the Drawings, Data Server Enclosures shall each be furnished with an interior, rack-mounted UPS. UPSs for rack-type enclosures shall meet the requirements specified below.

2-1.06.01. UPS for Free-Standing Vertical Panels and Wall Cabinets. Each UPS shall accept incoming 120 volts ac, 60Hz, single-phase utility power, apply surge protection, and supply power to the connected loads. The UPS shall be a double-conversion ("on-line") type to provide a breakless transfer to backup power. In the event of incoming power failure, the UPS shall provide 120 volts ac, 60 Hz, single-phase power to its connected loads by inverting power stored within integral storage batteries. The UPS shall be contained inside the enclosure and supported by a dedicated shelf attached to the backplane or sidewall. The shelf shall be between 12 and 18 inches from the bottom of the enclosure and shall not be directly above any electronic or electromechanical devices.

The UPS shall have at least two integral NEMA 5-15R receptacles for connection of battery-backed loads. Upon restoration of incoming power, the UPS shall recharge the batteries and return its connected loads to the incoming power source. The factory-installed line cord and plug shall not be altered. The UPS output shall be connected by plug and line cord to terminal blocks as necessary to distribute power to loads not having a power cord and plug; all other loads shall be connected directly to the UPS's integral receptacles or to permanently installed receptacles fed from the UPS output. A schematic showing the integration of the UPS within the enclosure is shown on the Drawings.

The UPS shall maintain a temperature-compensated, float charge voltage on the batteries when utility power is available. Overcurrent protection when utility power is available shall be from a circuit breaker internal to the UPS. The UPS shall be intrinsically current-limiting when the unit is on battery.

The UPS shall meet the following requirements.

Capacity, minimum	1000 VA / 700 watts
Filtering and surge Protection (on utility power)	Meets IEEE/ANSI C62.41 Category B (IEEE 587)
Voltage, output (on battery)	120 volts ±3 percent

Voltage, output (on-line)	Nominal ±3 percent
Frequency and waveform, output (on battery)	60 ± 0.3 Hz, true sine-wave
Efficiency, minimum (on-line)	90 percent
Operating environment	0 to 40ºC; 0 to 95 percent relative humidity, non-condensing
Backup time, minimum at half of rated load	10 minutes
Recharge time, maximum to 90 percent of full charge	12 hours

The UPS shall have spare capacity of at least 30 percent based on actual connected loads. The System Supplier shall advise the Design-Builder if the UPS capacity needs to be higher than specified above to meet this requirement.

The UPS shall have a visual status indicator for low (or faulty) battery and incoming ac power failure. The UPS shall emit an audible signal when the UPS is operating on battery power. A relay shall be installed within the panel and its coil connected across the UPS input power as a means of providing a contact for remote indication of a power failure condition.

The UPS shall be furnished with an Ethernet network card with RJ-45 connector for communicating status and alarm conditions to the Plant Control System. Communication shall be via 10/100-BaseT Ethernet and shall use HTTP, SMTP, SNMP, Modbus TCP, or other protocol as necessary to transfer the information into the HMI database for display and alarming. Special software or drivers necessary to complete the communications link shall be furnished with the UPS systems. One copy of any special software or drivers necessary to allow monitoring over the network shall be provided for all UPSs furnished under this section.

Batteries shall be sealed maintenance-free, gelled electrolyte lead-acid, or valve-regulated, maintenance-free, lead-acid. Flooded-electrolyte type batteries will not be acceptable.

The UPS shall be APC “Smart-UPS”, Vertiv/Liebert “GXT4”, Toshiba “1000 Series”, or equal.

2-1.06.02. Rack-Mounted Uninterruptible Power Supply (UPS). The UPS shall accept incoming 120 volts ac, 60 Hz, single-phase utility power, apply surge protection, and supply power to the connected loads. The UPS shall be a double-conversion ("on-line") type. In the event of incoming power failure, the UPS shall provide 120 volts ac, 60 Hz, single phase power to its connected loads by inverting power stored within integral storage batteries. UPS output shall be true sine-wave under both utility and battery operation.

The UPS shall be EIA 19-inch, rackmount-type and shall be furnished with all mounting accessories necessary to install it within the enclosure. The UPS shall have at least four integral NEMA 5-15R receptacles for connection of battery-backed loads. Upon restoration of incoming power, the UPS shall recharge the batteries and return its connected loads to the incoming power source. The factory-installed line cord and plug for input connection shall not be altered.

The UPS shall maintain a temperature-compensated, float charge voltage on the batteries when utility power is available. Overcurrent protection when utility power is available shall be from a circuit breaker internal to the UPS. The UPS shall be intrinsically current-limiting when the unit is on battery.

The UPS shall meet the following requirements.

Capacity, minimum	2000 VA / 1400 watts
Voltage, output (on battery)	120 volts ± 2 percent
Frequency, output (on battery)	60 ± 0.5 Hz
Efficiency, minimum (on-line)	90 percent
Operating environment	0 to 40°C; 0 to 95 percent relative humidity, non-condensing
Backup time, minimum at half of rated load	20 minutes
Recharge time, maximum to 90 percent of full charge	8 hours

The UPS shall have a visual status indicator for low (or faulty) battery, on bypass, UPS fault, and incoming ac power failure.

The UPS shall be furnished with an Ethernet network card with RJ-45 jack for communicating status and alarm conditions to the Plant Control System. Communication shall be via 10/100-BaseT Ethernet and shall use HTTP, SMTP, SNMP, or other protocol as necessary to transfer the information into the HMI database for display and alarming. One copy of any special software or drivers necessary to allow monitoring over the network shall be provided for all UPSs furnished under this section.

Batteries shall be sealed maintenance-free, gelled electrolyte lead-acid, or valve-regulated, maintenance-free, lead-acid. Flooded-electrolyte type batteries will not be acceptable. Additional rack-mounted battery modules shall be supplied to meet runtime requirements.

The UPS shall be APC “Smart-UPS RT”, Vertiv/Liebert “GXT4 Rack Mount”, Toshiba “1000 Rack Mount”, or equal.

2-1.07. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the Instrument Device Schedule and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated identification tags securely fastened to the device. The indentification tags shall be Rowmark UltraGrave Matte or equal. Hand-lettered labels or tape labels will not be permitted.

2-1.08. Nameplates. Nameplates shall be provided on the face of the panel or on the individual device. Panel nameplates shall have legends and approximate dimensions as indicated on the Drawings and shall be made of laminated material having engraved letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be Rowmark UltraGrave Matte or equal. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified under the Device Tag Numbering System paragraph.

2-1.09. Indicating Light Color Designations. Indicating lights are specified in the Panel Mounted Instruments section. Indicating lights shall be colored as shown in the following table unless indicated otherwise on the Drawings, in other specification sections, or in the instrument device schedule.

Color	Meaning
Red	Associated equipment or device is “running, “ “open,” or is in an “unsafe” state or position.
Green	Associated equipment or device is “stopped,” “closed,” or is in a “safe” state or position.

Color	Meaning
Yellow/Amber	Associated equipment or device has “failed” or a process alarm condition is present or imminent.
White	All other conditions not defined above.

2-1.10. Painting. Interior and exterior surfaces of all stainless steel and carbon steel panels shall be thoroughly cleaned and painted with rust inhibitive (universal) primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils. Color shall be ANSI 61 Graywhite. Color samples shall be submitted to Design-Builder for color selection. One quart of touch-up paint shall be furnished with the panels.

2-1.11. Panel-Mounted Instruments. Instruments, power supplies, pilot devices, and appurtenances mounted within or on the face of the panel shall meet the requirements specified in the Panel Mounted Instruments section for those items unless noted otherwise herein, on the Drawings or, if applicable, within the referring equipment specification section.

2-1.12. Factory Test. Panels shall be factory tested electrically and pneumatically by the panel fabricator before shipment.

2-2. FREESTANDING VERTICAL PANELS. The following paragraphs specify the freestanding vertical panels:

2-2.01. Construction. Panel construction shall be an indoor, dusttight, completely enclosed cubicle formed from steel structural members and steel plates. The base shall be formed of steel channels, with flanges extending upwards. The base shall be provided with 1/2 inch diameter holes at 12 inch centers so that the base can be bolted to the concrete equipment base. Welds, seams, and edges on all exposed surfaces shall be ground smooth. Suitable lifting facilities shall be provided for handling and shipment.

2-2.02. Structure. Panel structure shall be suitably braced and of sufficient strength to support all equipment mounted on or within, to withstand handling and shipment, to remain in proper alignment, and to be rigid and freestanding. Top, sides, and back shall be fabricated from USS 10 gage or heavier stainless steel or carbon steel sheets, with stationary back suitable for back to wall installation, or designed for rear access with hinged back doors. Doors shall not be greater than 24 inches wide or spaced not greater than 36 inches center to center. Rear access doors shall be fabricated from USS 14 gage or heavier stainless steel or carbon steel.

2-2.03. Panel Front. The front shall be a hinged door, or doors, with mounted instruments and control devices, fabricated from USS 10 gage stainless steel or carbon steel sheet and suitably braced and supported to maintain alignment. Panels with hinged fronts shall be of sufficient width to permit door opening without interference with rear projection of flush mounted instruments.

2-2.04. Doors. Doors shall be essentially full height, having turned back edges and additional bracing to ensure rigidity and prevent sagging. Doors shall be mounted with strong, continuous, piano type hinges. Positive latches, acting from a common door handle, shall hold doors securely compressed at top, side, and bottom against rubber gaskets.

2-2.05. Mounted Instruments. The front shall be stationary, with mounted instruments and control devices, fabricated from 3/16 inch steel or carbon steel plate. Panel fronts shall be suitably reinforced between mounting cutouts and drilling to support instruments and devices without deformation and shall be free from waves and other imperfections. Panel fronts shall be recessed at the base. Adjoining panel sections shall be accurately shop fitted to assure satisfactory assembly in the field.

2-2.05.01. Instrument Arrangement. Panel instruments and control devices shall be arranged in a logical configuration for the plant operators. The centerline of recorders shall be within 3 feet and 5'-9" above the base of the panel for convenient reading and chart replacement. Control switches shall be within 6 feet and 2'-6" above the base of the panel. Indicators may be located within 2'-6" and 6'-6" above the base of the panels.

2-2.06. Conduit Entrance. Not used.

2-2.07. Size and Arrangement. Panel dimensions and general instrument arrangement shall be as indicated on the Drawings or in the attached equipment schedules.

2-2.08. Interior Lighting. Illumination of panel interiors shall be provided by ceiling mounted lamp fixtures spaced at approximately 2'-6" and near the door. Fixtures shall be nominal 40-watt LED/fluorescent tube type, with a common "On-Off" switch near each end door. Duplex-grounded receptacles shall be provided for service and maintenance tools at spacing not greater than 5 feet throughout the length of a panel. The lighting and receptacle circuit shall be fused separately from the instrumentation systems.

2-3. FILTER CONSOLES. Not used.

2-4. WALL-MOUNTED CABINETS. Cabinets, which contain the system components indicated on the Drawings, shall be suitable for wall mounting and shall meet the NEMA enclosure rating as indicated on the Drawings or, if

applicable, in the attached equipment schedules or the referring equipment specification section. The enclosures shall be fabricated from USS 14 gage, or heavier, carbon steel or stainless steel. Cabinets shall be equipped with full size gasketed doors with hinges and a chromium-plated or stainless steel three-point latch. The door shall be lockable with a key. A screened vent shall be provided in the bottom of enclosures that contain pneumatic devices.

Floor stands shall be provided to support cabinets not fastened to a wall or other support. Floor stands shall be full-depth and shall have a minimum height of 12 inches. Floor stand material and finish shall match the cabinet.

All wall-mounted cabinets shall meet the requirements of the panel fabrication paragraph of this section.

Outdoor cabinets shall be provided with sunshades as indicated on the Drawings or, if applicable, in the attached equipment schedules or the referring equipment specification section.

2-5. FIBER OPTIC PATCH PANELS. Fiber optic patch panels (also referred to as fiber termination cabinets) shall be furnished to terminate fibers at the fiber optic modules, and any other data highway attached equipment. The cabinets shall meet the following requirements:

a. The patch panels shall be the wall rack mounted type, having provisions for terminating multiple fiber optic cables. Splice trays, strain relief cable attachment points, fiber organizers and bend radius hardware shall be furnished with each termination cabinet.

b. Panel size shall be suited to the number of fibers to be terminated within the cabinet. Bayonet/flanged couplings shall be furnished and mounted for each fiber to be terminated.

c. Fiber terminations shall be spliced to pigtail cables (specified below) having ST connectors. The pigtails shall be terminated in an orderly method.

Fiber optic patch panels shall be OFS Technologies “LGX”, Corning Cable Systems “WCH Series”, or equal.

2-6. FREESTANDING EIA 19-INCH RACK ENCLOSURES. Not used.

2-7. DATA SERVER ENCLOSURES. An enclosed equipment distribution rack shall be provided for mounting network equipment provided as rack-mounted, including switches, firewalls, routers, and patch panels. The rack shall be black painted steel or painted aluminum construction with fully tapped, standard 18.3 inch hole-to-hole centers and shall include all hardware and accessories including frame, shelves, and raceways as specified and as shown on Drawings.

Rack enclosures shall be as manufactured by Amco Engineering, Hoffman, or equal.

Each data server enclosure shall be furnished with a rack-mounted uninterruptible power supply (UPS) to provide backup power to all enclosed loads. Rack-mounted UPSs are specified elsewhere in this section.

2-8. WALL MOUNTED INSTRUMENT SUBPANELS. Instrument subpanels shall be constructed from 1/8 inch thick stainless steel or carbon steel and shall be reinforced and braced to form a rigid assembly. Panels designed for wall mounting shall have 1 inch turned back edges and a minimum 2 inch air space between the panel and the wall surface. All components on wall-mounted panels shall be mounted so as to be easily removable without requiring rear access to the subpanel.

2-9. CONTROL SYSTEM CONSOLES AND ENCLOSURES. A main control system console and printer enclosure and printer stand shall be provided as indicated on the Drawings.

2-9.01. Control System Console. The control system console shall be a modular system consisting of straight, angular, and corner sections to provide an arrangement as indicated on the Drawings. Console sub-structure shall consist of a welded steel frame and extruded aluminum horizontal supports. Structural arrangement shall allow connection of modular sections to produce a seamless equipment mounting enclosure.

2-9.01.01. Internal Wiring. Integral wireways and surge-protected receptacles shall be provided throughout the console structure. System Supplier shall coordinate the receptacle spacing and number to ensure adequate power connections are available for the equipment to be located in the console. System Supplier shall coordinate with the CCTV, Security, Intercom, and Radio Suppliers and install receptacles for powering the associated equipment.

2-9.01.02. Equipment Mounting. Equipment mounting kits shall be provided to support the equipment items to be located in the console. This shall include, but not be limited to, operator workstation monitors, operator workstation computers, workstation servers, historical/data collection components, and printers. Kits shall be provided for CCTV, security, intercom, and radio equipment. Monitor support shelves shall be adjustable to allow monitors of various sizes to be centered in the front panel. Central processing unit (CPU) support shelves shall be of the slideout type.

2-9.01.03. Exterior Panels. Console exterior panels shall be attached to the console structure with concealed hardware and shall be removable without the need for tools. Where indicated on the Drawings, hinged access panels shall be

provided. Exterior panels shall be constructed of rift cut domestic red oak veneer over composite coreplastic laminate over composite coreformed, painted metal.

2-9.01.04. Work Surface. Work surface shall be 1 inch core, with high-pressure laminate surface and backing. Work surface nosing and edge shall be solid oak, finished to match the exterior panelsshall be soft urethane with plastic laminate edges. Base trim shall be high-pressure laminate over composite core to match work surface.

2-9.01.05. Console Front. The front surfaces of the console shall be oak veneerplastic laminate over composite coreformed, painted metal with window cutout sized to accommodate the monitors provided. Hinged, glare control glass and shall be provided for access to the monitor. Continuous task lighting shall be provided along the length of the monitor mounting area valance or retractable task lights shall be provided on each end section of the console.

2-9.01.06. Color Samples. System Supplier shall submit color samples for all exterior panel, work surface, equipment front, and edge surfaces to Design-Builder for color selection.

2-9.01.07. Manufacturers. The console shall be Evans “Strategy Series” or "Identity Series" or Tresco Consoles “3600”.

2-9.01.08. Printer Enclosures. Printer enclosures shall be of a noise buffering type, furnished in the quantities indicated on the Drawings. The printer enclosure shall be of the same general construction and finish as the control system console. The enclosure shall be provided with a hinged glass cover with pneumatic supports to hold the cover in the raised position. The enclosure shall have a support shelf with paper access slot for the printer provided. Under shelf storage space shall be sufficient to store a standard carton of 11x14 inch computer paper. The paper storage area shall be accessible through hinged access doors on the enclosure front.

2-9.01.09. Printer Stands. Printer stands shall be an open shelf design, sized to support the report printer provided. The stand shall be provided with shelved storage space under the printer-mounting surface. Access to the storage space will be through lockable doors. The cabinet shall be constructed of materials to match the control system console exterior panels. Printer mounting surface height shall be approximately the same as the work surface of the control console. The printer stand shall be provided by the control console manufacturer.

2-9.01.10. Task Lighting. Task lighting shall consist of a continuous bank of lighting.Task lighting shall consist of three articulating lamps mounted on brackets.

2-10. CONTROL SYSTEM FURNITURE. A control system desk and printer enclosuresprinter stands shall be provided as indicated on the Drawings.

2-10.01. Control System Desk. The control system desk shall be a freestanding desk-based system consisting of linked work surfaces on pedestals in the general arrangement indicated on the Drawings. System Supplier shall coordinate the types and quantities of console components required, and shall furnish and install all additional components, including supports and connecting brackets.

2-10.02. Work Surfaces. Work surfaces shall of be high-pressure plastic laminate over a high-density wood composite and shall be 1-1/4 inches thick, 30 inches wide, and of the length required. Special corner work surfaces shall be provided where required. Back panels at least 19 inches high shall be provided for all work surfaces. Work surface dimensions shall be coordinated with the pedestals to ensure proper stability and access to wireways. Where indicated on the Drawings, work surfaces shall be provided with hinged corner access channels for wire and cables.

2-10.03. Pedestals. Pedestals shall be provided as indicated on the Drawings to support the work surface arrangement. Pedestals shall be of painted steel, with integral, double-walled desk drawers.

2-10.04. Internal Wiring. The console shall be provided with a concealed wireway system, mounted near the back edge of the work surface and accessible from the console back without the use of special tools. An integral power raceway system shall be provided to distribute power to the control system components. The power system shall consist of sufficient receptacles and wiring to accommodate the control system components and task lighting.

2-10.05. Task Lighting. Task lighting for work surfaces shall be installed along the back panels. Lighting shall consist of continuous track lighting or articulating lamps mounted on brackets.

2-10.06. CPU Mounting. Mounting kits shall be provided for installing CPUs under the work surfaces. The numbers and locations of the CPUs are indicated on the Drawings.

2-10.07. Color Samples. System Supplier shall submit color samples for all work surfaces, back panels, and pedestals to the Design-Builder for color selection.

2-10.08. Manufacturers. The console shall be as manufactured by Allsteel or equal.

2-10.09. Printer Stands. Printer stands shall be of open shelf design, with lockable doors, sized to support the report, alarm, or color printer furnished, and with shelved storage space under the mounting surface. The control console manufacturer shall provide the printer stands.

2-10.10. Printer Enclosure. Printer enclosures shall be constructed of materials to match the control system console exterior panels. Printer mounting surface shall be of approximately the same height as the work surface of the control console.

PART 3 - EXECUTION

3-1. GENERAL INSTALLATION REQUIREMENTS. Installation requirements are specified in the Instrumentation and Control System section. In addition, equipment furnished under this section shall conform to the following manufacturing stipulations.

3-1.01. Piping. All tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipment. Flexible polyethylene tubing shall be used to connect devices mounted on hinged doors.

3-1.02. Wiring. All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40 percent of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

3-1.03. More Than One Panel. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic Drawings.

End of Section

Equipment Schedule 40 67 11-S01

FREESTANDING VERTICAL PANELS

1.000	**General**					
1.010	Specification Section 40 67 11					
2.000	**Freestanding Vertical Panels**					
2.010	Tag Number/Panel ID	21-CTRL-LCP-0001	31-CTRL-LCP-0001	51-CTRL-LCP-0001	72-CTRL-LCP-0001	80-CTRL-LCP-0001
2.020	NEMA Enclosure Rating					
	12			X		X
	4					
	4X	X	X		X	
2.030	Materials of construction					
	Carbon steel			X		X
	316 Stainless steel	X	X		X	
	Fiberglass polyester					
2.040	Environmental provisions					
	Sunshade and drip shield	X	X		X	
	Cooling fan					
	Air conditioner	X	X		X	
2.050	Door Arrangements					
	Hinged rear doors					
	Hinged front door with instruments					
	Hinged front door without instruments	X	X	X	X	X
	Fixed front					
	Recessed base	X	X	X	X	X
2.070	Panel interior-mounted UPS	X	X	X	X	X
2.080	Conduit entrance					
	Bottom open					
	Removable top plates					
3.000	**Exceptions, Clarifications, and Comments**					
3.010	None					

1.000	**General**					
1.010	Specification Section 40 67 11					
2.000	**Freestanding Vertical Panels**					
2.010	Tag Number/Panel ID	90-CTRL-LCP-0001				
2.020	NEMA Enclosure Rating					
	12					
	4					
	4X	X				
2.030	Materials of construction					
	Carbon steel					
	316 Stainless steel	X				
	Fiberglass polyester					
2.040	Environmental provisions					
	Sunshade and drip shield	X				
	Cooling fan					
	Air conditioner	X				
2.050	Door Arrangements					
	Hinged rear doors					
	Hinged front door with instruments					
	Hinged front door without instruments	X				
	Fixed front					
	Recessed base	X				
2.070	Panel interior-mounted UPS	X				
2.080	Conduit entrance					
	Bottom open					
	Removable top plates					
3.000	**Exceptions, Clarifications, and Comments**					
3.010	None					

Equipment Schedule 40 67 11-S02

WALL-MOUNTED CABINETS

1.000	**General**					
1.010	Specification Section 40 67 11					
2.000	**Wall Mounted Cabinets**					
2.010	Tag Number/Panel ID	81-GEN-FPP-001				
2.020	NEMA Enclosure Rating					
	12					
	3R					
	4					
	4X	X				
2.030	Materials of construction					
	Carbon steel					
	316 Stainless steel	X				
	Fiberglass polyester					
2.040	Environmental provisions					
	Sun shade	X				
	Cooling fan					
	Air conditioner					
3.000	**Exceptions, Clarifications, and Comments**					
3.010	None					

Equipment Schedule 40 67 11-S03

NETWORK RACKS

1.000	**General**				
1.010	Specification Section 40 67 11				
2.000	**Network Racks**				
2.010	Tag Number/Panel ID	95-CTRL-SVR-0001	95-CTRL-SVR-0002	95-SEC-SVR-0001	95-ADMIN-SVR-0001
2.020	Rack Features				
	Open Frame				
	Enclosed	X	X	X	X
	Wall Mounted				
	Floor Mounted	X	X	X	X
	Doors with Windows	X	X	X	X
2.030	Materials				
	Carbon steel	X	X	X	X
	Stainless steel				
	Fiberglass polyester				
2.040	Optional Accessories				
	Internal UPS	X	X	X	X
	Vertical Cable Management	X	X	X	X
	Horizontal Cable Management	X	X	X	X
	Light	X	X	X	X
	Power Distribution Unit	X	X	X	X
3.000	**Exceptions, Clarifications, and Comments**				

Section 40 68 16

COMPUTER SYSTEM SOFTWARE

PART 1 – GENERAL

1-1. SCOPE. This section covers computer system software to be furnished and installed by System Supplier on computer hardware specified in another section.

System Supplier shall furnish standard, field proven, fully debugged and supported software packages for this application with a minimum of additions or changes. Customized or specially written software shall be furnished only if required to meet all functional requirements specified herein.

Software is described in functional categories. System Supplier shall furnish a complete software package including the functional requirements specified, along with any additional software required for proper and efficient operation of the system.

No attempt has been made to list all software or all characteristics of software required by System Supplier to meet the functional requirements specified, nor to determine the location of the software modules within the system.

The computer control software shall meet the design conditions and performance.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all software furnished under this section. Additional software requirements are indicated in the Software Control Block Descriptions section. Software configuration programming standards shall be as discussed in the Instrumentation and Control System section.

1-2. GENERAL. Software packages shall control computer system level activities as well as higher level process control activities, allowing the process to be monitored and controlled through an interactive operator interface.

1-2.01. Interface. Users shall be able to interface to all process control activities through fully interactive software modules initiated and operated using easily recognized icons or custom symbols or driven by full-screen and pull-down menus. Selection of icons or menus shall be through pointing devices and shall not normally require the use of an alphanumeric keyboard. Systems that require the use of typed commands to move from module to module or from display to display are not acceptable**.**

1-2.02. Execution. Throughout the execution of all software modules, the operator shall be presented with all command or operation choices available at that point in the program to make the choices self-explanatory and unambiguous. Question-and-answer or fill-in-the-blank requests are acceptable only where file names, tag names, or other unique text or numerical information is required.

1-2.03. Configuration. All programs shall be self-configuring to obtain the size and configuration of the system from parameters contained in the various files created during system generation. No parameters related to the hardware configuration shall be hard coded into any of the software.

1-2.04. Version. All programs shall be the latest version commercially available at the time the system is delivered to Owner. Superseded versions, revisions, or releases are not acceptable.

1-2.05. Drawings. Supplementing this section, the Drawings indicate locations and arrangement of computer enclosures and provide one-line and block diagrams regarding the connection and interaction with other equipment.

1-3. SUBMITTALS. In addition to the requirements of the Instrumentation and Control System section, a complete description of the software packages and modules shall be submitted to verify compliance with this section.

1-4. DELIVERY AND SHIPPING. Delivery and shipping shall be as in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. OPERATING SYSTEM SOFTWARE. Operating system software shall be MS Windows Server 2016 for servers and MS Windows 10 for workstations, without exception, and shall include a complete and unmodified operating system that provides system level functions.

2-2. PROCESS CONTROL SYSTEM APPLICATION SOFTWARE. Process control software shall enable the operator to monitor and control field devices connected to PLCs or other input/output hardware. The process control system application software shall meet the following minimum requirements and shall exceed these requirements where necessary to comply with the functional requirements of the project.

A license shall be issued for each machine loaded with process control software.

2-2.01. Approved Software. The process control system application software shall be Wonderware System Platform, without exception.

A dual network shall be provided to insure LAN redundancy.

The control system hardware is specified in another section.

2-2.02. Password Protection. Operator access within the control system software shall be controllable through a password-based security scheme. Operators shall be assigned their own user account and password. Nine levels of security protection shall be provided. Each system display, database block, control action, and software module shall be assigned its own security levels and shall be inaccessible to users without proper security clearance. After initial creation, passwords shall be field alterable, but only by the assigned user or a system administrator.

2-2.03. System Response. All responses to the operator shall be clear, unambiguous, and complete. Every operator menu, target selection, or request shall generate a response providing the range of choices for the next step in the process or indicating that the request or chosen operation has been completed, is being processed, or cannot be performed. Every operator menu or target pick shall generate a graphic or text message response, even if it is a negative one.

2-2.04. Interactive Software Commands. The software's interactive command structures, user interface, menu organization, and procedures shall be consistent and predictable for all software modules throughout the system. Similar operations shall be performed in a similar manner, so that an operator will not need to learn different techniques for initiating the same operation in different software modules.

2-2.05. Operator Commands. The software shall accept each operator command or selection, decode it, and check its validity and correctness in the sequence of data and operations previously presented. Invalid or incorrect commands or menu selections shall not be processed; instead, a message shall be generated which explains why the command or menu selection is invalid. When a command or selection is canceled prior to being fully processed, the software shall clear all pending sequences and shall not initiate any system control commands.

2-2.06. Database. The software shall include a comprehensive interactive database system for creating, sorting, editing, and monitoring all process inputs and outputs and internally used variables and control blocks. The system shall request, receive, process, and store all real-time data according to the information contained in the database. Database points shall be enabled or disabled individually at any time by an operator working at the proper security level. All internal database point information shall be accessible to other external database software applications through ODBC, export of comma separated value or direct SQL commands.

2-2.07. Interactive Database Editor. An interactive database editor software module shall be provided for creation, inspection, and modification of database entries. Modification, addition, or deletion of database information shall not require direct changes to the program source code. Changes made in the database contents or formatting shall automatically update all locations at which the information is stored or used.

2-2.08. Custom Algorithms. The software shall enable the users to create their own custom algorithms or command sequences through accessing database points, internal pseudo-point variables, math and logic comparisons, and standard system functions. Each algorithm and command sequence shall run independently and shall be configurable to be executed on demand, based upon an event or condition, on a timed-interval, or at a set time of day.

2-2.09. Programming Language. A programming-type language or environment shall be considered acceptable if it is integrated into the base control system software product; if any compilers, linkers, and other necessary software modules are either included with the base software or supplied and configured by System Supplier; if technical support is provided directly by the control software vendor; and if all control system database points and variables are accessible to the programmer.

2-2.10. Alarm Processing. Alarm processing software shall be provided to recognize and report alarms to the operator in an organized, unambiguous, clear, and convenient manner. Alarms shall be classified into at least five priority levels and at least two independent classes. System events shall be considered alarms classified by their own specific priority or class.

2-2.10.01. Alarms. Alarm processing software shall generate alarms for at least the following conditions.

Discrete input or output change of state if defined as an alarm in the database.

Analog value exceeding the alarm limits defined in the database.

Analog rate of change exceeding the limits defined in the database.

Failure of any process input/output hardware, communications link, or other major hardware component.

2-2.10.02. Acknowledgment. Alarms shall be generated as they occur and shall not be cleared until they have been acknowledged and conditions have returned to normal. Alarms shall clear from each operator workstation once they have been acknowledged from any workstation.

2-2.10.03. Alarm Summary Display. An alarm summary display shall be provided which lists at least 100 of the most recent alarms in all classes, with the most recent alarm listed first. Alarms shall appear flashing or in a unique color until they are acknowledged by the operator. Alarms of different priorities shall be easily distinguished on all alarm displays through the use of unique colors or similar methods.

2-2.10.04. Alarm Logging. Alarm logs shall constitute a hard-copy record and a soft-copy record saved in the historical database of all alarms, events, and significant operator actions. Alarm displays and alarm log entries shall include the date and time that the alarm was detected, the tag name and description of the alarmed point, and an entry describing the nature of the alarm. Alarms shall be logged on an alarm and event printer and saved in the historical database as they occur.

2-2.10.05. Responses to Alarms. An audible alarm shall sound at the operator's console at each occurrence of a new alarm event. The audible alarm shall be silenced when it is acknowledged by the operator.

Voice annunciation shall be used to annunciate alarm events.

The audible alarm shall use an external sound system, such as a sound card and external speakers.

2-2.10.06. Alarm Enabling. Alarms originating from database entries such as discrete change of state or analog limit violations shall be enabled or disabled on a point-by-point basis.

Alarms shall be capable of being shelved for an operator-entered period of time. After the alarm shelving time period has elapsed, the shelved alarm shall become active again.

2-2.10.07. Alarm Notification Software. An external or integral alarm notification software package shall be provided to generate alarms for paging, texting, voice call, or email systems. Two licensed copies of the software shall be provided. External software packages shall be Win911 or SCADAlarm, or equal. Integral software packages shall be equivalent to the listed external software packages.

2-2.11. Operator Interface. System software shall be suitable for creation and modification of alphanumeric and graphic displays and linking of dynamic fields to database variables.

2-2.12. System Storage. The system shall be capable of storing and utilizing 300 full-screen user displays and pop-up windows, each containing any number of the following components.

Static and dynamic alphanumeric information.

Static and dynamic or object-based graphics.

Dynamic bar graph displays.

Dynamic analog real-time and historical trend displays.

Static and dynamic bitmap (Windows .BMP compatible) graphics.

2-2.13. Component and Configuration Information. The software shall enable the user to reuse components and configuration information from any screen or pop-up window with or without modification. All configuration information shall be displayed in any of 256 colors, flashing or non-flashing. Dynamic fields shall change color or from flashing to non-flashing and back in response to a change in value, state, or alarm condition of the linked variable. Dynamic objects linked to process inputs and outputs shall be capable of displaying at least three equipment states, such as on/off/alarm for pumps, or open/close/transition for valves.

2-2.14. Communications. System software shall support communications among computers and PLCs as indicated on the Drawings and as specified herein. System Supplier shall be responsible for any device driver development required to support the communications indicated.

2-2.14.01. Data Retrieval and Transmission. The software shall retrieve and send data from and to all remote field devices indicated on the Drawings. The software shall perform all required error checking to ensure the validity of all data transactions and proper completion of the scan sequence. All communication system malfunctions, including "no response", shall be reported to the system as alarms. Re-transmission shall be utilized to correct or overcome communication errors.

2-2.14.02. Communications Driver. The software shall be supplied with communications drivers capable of communicating with any existing remote field devices indicated on the Drawings as well as all software input/output drivers required to communicate with all field devices and system hardware that are furnished as part of the control system.

Network communications drivers shall be provided for notification and alarming of SNMP compliant devices, such switches and routers. Drivers shall be OPC to SNMP drivers. Generic OPC drivers shall be provided for the HMI software as required. Drivers shall be Kepware, Matrikon or equal.

2-2.15. Historical Data Storage. The software shall include modules for historical data gathering, data reduction, and reporting. Real-time analog signal values shall be collected and stored in the historical database based on a user defined time interval of 1 second to 1 day, or on a change of state deadband configured for each database point. Alarms and events shall be collected and

stored in the historical database as they occur. The historian shall support the following features.

The historical database shall be a real-time relational database. The database shall be an extension of Microsoft SQL Server. The historical database shall acquire point information from the graphical user database.

Access to data shall be by any SQL or ODBC compliant software package, such as Crystal Reports, Oracle database applications, Microsoft Excel, or Microsoft Access.

Database shall allow the use of a separate I/O server for data from the programmable logic controller system.

2-2.15.01. Data Reduction Capabilities. Data reduction capabilities shall be provided to average and reduce data to hourly records, and the hourly records to daily records. Entries for all hourly and daily averaged records shall include sample, average, minimum and maximum values as defined by Owner. Both hourly and daily averages for each day shall be stored in the historical database.

2-2.15.02. Retrieval Software. Data retrieval software shall be provided to allow access to historical data files for the following uses:

Tools shall be provided for remote trending and display of the data on all user workstations. Trend displays shall allow up to eight tags to be graphed in the window. Graphs shall allow stacking or separate display of each tag. Displays shall allow save functions for retrieval from the computer hard drive. Trends shall display real-time data or display data from the history files. The trend display shall show the time frame of stored data.

Import/export of data from/to ASCII files.

Inclusion in user-generated reports.

Tools for Microsoft Excel display of data shall be included. Tools shall allow the retrieval and display of real-time data, or historical data.

2-2.16. Reports. Report logs shall constitute a hard-copy summary of user-selected process data. At least 30 report formats shall be available in the system. Report printing software shall include a user-interactive, on-line report editor to allow the operator to select the following parameters for each report.

Data consisting of measured variables, calculated variables, and manually entered data.

Starting and ending time of data to be included in the report.

Print format for each variable.

Titles and subtitles to appear on each page of the report, including report name, current time, and date.

Paper width (from 8 to 14 inches).

Print pitch (from 5 to 16.5 characters per inch).

Number of columns on each page.

Number of lines per page and number of pages per report.

2-2.16.01. Database Points. All database points in the system, including all input/output points, manually entered points, and calculated points, shall be available for use in reports. Reports shall include sample, average, minimum, and maximum values for analog variables and the time of occurrence for minimum and maximum values. Information printable for discrete variables shall include running time, state, and transition count.

2-2.16.02. Report Formats. Report logs shall constitute a file or a hard-copy summary of user-selected process data. All historical data for points in the history database shall be available for reporting from an SQL and ODBC compliant database. Reporting software shall have the following features:

Creation and modification of report formats or content shall not require direct modification of system source code. Reports shall have the ability to be created in third party software packages such as Microsoft Excel and Microsoft Access.

Report format spreadsheet package shall be Excel.

2-2.17. Off-line Storage Software. The software shall include provisions for copying to backup media any or all of the historical data currently stored on the hard drive. The software shall support archival of data to any backup devices specified in the Computer System Hardware section. Archival of data shall be intuitive and the archival software shall guide an operator through the backup process.

2-2.17.01. Backup Data. Once historical data is copied to back-up media, the software shall allow the operator to delete it without negative consequences to free space on the hard drive. Archived historical data shall be re-loadable and usable in all the same ways as historical data that has not been removed from the local hard drive.

2-2.17.02. Logical Disk Drive. If the backup device is on-line and addressable by a logical disk drive letter (e.g., an optical disk drive defined as "D:"), historical data archived to that device shall be accessible directly without restoration to a local hard drive.

2-2.17.03. Internet/Intranet Connectivity. The software shall include provisions for making connections to the process data through the existing corporate Intranet or through a connection made on the Internet. This “thin client” solution shall provide authorized users access to all displays and process information by utilizing any standard Internet browser.

The application software shall include software for development for web browser-based interface. Features shall include the following:

The software shall allow access to the real-time process operations through any web browser without special software on the computer.

The software shall provide security to prevent unauthorized use.

The software shall allow the user to view alarms through the browser.

The software shall allow the user to view historical data through the browser.

2-3. SOFTWARE DOCUMENTATION. System Supplier shall relinquish all documentation supplied with the software furnished, such as user manuals, programmer guides, reference cards or keyboard templates, and related materials. In addition, System Supplier shall generate and submit to Owner and Engineer written documentation of any configuration work, modifications of the system, or setup of software done before or after installation of equipment on the site. Documentation shall be electronic. This includes any and all information on the development of any standard “objects,” “wizards,” or “scripts” created for the use in this project.

2-4. PLC SOFTWARE. The requirements for PLC software are specified in the Programmable Logic Controller section.

2-5. EXTENDED SUPPORT OR WARRANTY. The process control system software shall include the extended or comprehensive support service of the manufacturer. The service shall include all software updates and phone and personal support when needed. The service shall be for a period of one year after final acceptance and shall cover all software packages supplied under this contract.

2-6. TRAINING SERVICES. Training requirements are specified in the Instrumentation and Control System section.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. The System Supplier shall install the process control software on the control system hardware specified in another section.

3-1.01. Configuration. System Supplier shall install and properly configure any supplemental programs, modules, and software packages necessary to meet the functional requirements of the project as described in the Instrumentation and Control System and Software Control Block Description sections.

3-1.02. Quantity. The System Supplier shall install one full development software package(s) on the control system server(s) and a runtime software packages, on each of the operator workstations.

End of Section

Section 40 68 83

SOFTWARE CONTROL BLOCK DESCRIPTIONS

PART 1 - GENERAL

1-1. SCOPE. This section provides functional descriptions of the PLC and computer software requirements for the Instrumentation and Control System as indicated on the Drawings. These descriptions are intended to provide an overview of the operating concept of the plant process equipment rather than describing in detail every operating feature or interlock.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all systems described in this section.

PART 2 – PRODUCTS

2-1. GENERAL. The descriptions are applicable to the software specified in the Computer System Software section and Programmable Logic Controller section.

PART 3 - EXECUTION

3-1. PLC PROGRAMMING FUNCTIONAL REQUIREMENTS. The following paragraphs describe general configuration tasks that are required for the Design-Builder provided PLC(s) and vendor packaged system PLC(s). These tasks shall be programmed in any applicable PLC. Each PLC may have multiple instances of each of these tasks or may have no instances of some or all of these tasks. The input/output lists (located in these documents as specified in the Instrumentation and Control System section) and detailed equipment control descriptions (included herein) shall be referenced to determine the requirements for each PLC.

The following paragraphs cover functional requirements of the software, which are generic and may or may not be related to any specific control loop.

3-1.01. Available Process Values. All PLC-generated process alarm, equipment status, and process variable values shall be available at any operator workstation.

3-1.02. Flow Values. Flow values shall be integrated, totalized, and stored in the PLC registers so the values displayed on the HMI computers and on the field processor shall be identical.

3-1.03. System Failure. Failure of a PLC shall result in safe shutdown of associated process equipment. Interposing relays shall be provided where required to assure that equipment will revert to its fail-safe condition. Failure of any PLC or its communication shall be alarmed on the HMI computer.

3-1.04. HMI Computers. The HMI computers shall function as a monitoring system, not as a controller, for the process equipment. The computer shall download set points, commands and other information to the PLCs, and the PLCs shall perform all control algorithms, so a temporary failure of any of the HMI computer will not disrupt plant control.

3-1.05. Rack/Module Configuration. The rack and module definitions for each PLC, as well as the PLC communications configuration shall be completely configured to allow proper addressing of all field connected I/O points. This shall include configuration of any remote input/output (RIO) racks.

3-1.06. PLC Database Definition. The PLC database will include both field I/O points and internally generated points required for programming. All field I/O points and internal programming points shall be fully defined according to database naming conventions approved by Owner. As a minimum, each database point shall be provided with a tag name, engineering unit, alarm parameters, and description.

3-1.07. Analog Scaling. Each analog input and output shall be appropriately scaled for use in internal PLC programming, monitoring by the HMI computers, or transmission to other PLCs. Requirements for raw count values shall be coordinated with the operator interface software to ensure compatibility.

3-1.08. Equipment Runtimes. For each equipment item whose "run" status is monitored by a PLC, an internal equipment runtime shall be accumulated by the respective PLC. The runtime procedure will monitor the status of the equipment "run" contact and, when the equipment is running, increment a software timer that maintains equipment runtime to within a one-minute resolution. The timer shall stop incrementing, but not reset, when the "run" contact indicates that the equipment is not running. The timer value shall increment an hour counter that maintains an integer value representing the equipment run time in hours. The counter value shall be available for display on the HMI computer. A manual reset of the runtime value shall be available at the HMI computers for personnel at the supervisor level and above.

3-1.09. Change-of-State Alarms. While equipment is controllable from the PLC ("in remote"), discrete output commands shall be compared to their respective process feedback status signal (where available) to verify proper execution. If the feedback status does not match the most recent output command (after an adjustable 2 to 300 second time delay), an alarm message shall be displayed on the HMI computer and the condition shall be logged as an alarm, requiring

operator acknowledgment. The alarm shall remain energized until the proper discrete condition is sensed or until the operator resets the alarm through the HMI computer.

3-1.10. Equipment Availability. In general, equipment with PLC control has been provided with a local selector switch that transfers control to the PLC. The PLC shall monitor the position of this switch to determine if the equipment is available for PLC control. If the equipment is not available, the PLC program shall not attempt to implement remote manual or automatic status changes for the equipment. The PLC program may, however, need to implement special routines if equipment unavailability affects a sequence (as described in the detailed equipment descriptions).

3-1.11. Maintained/Momentary Outputs. The need for maintained or momentary control outputs shall be determined from the input/output listing and the electrical schematics. In general, equipment with only one control output indicated in the I/O list shall be programmed for a maintained control output. Equipment with two (or more) control outputs shall be programmed for momentary outputs. Provisions shall be made, in either case, to remove the active state (start, open, forward, initiate, etc.) control output when an equipment failure is sensed or when the equipment transitions from available to unavailable (local switch change).

3-1.12. Equipment Mode Changes. Unless otherwise indicated in the equipment control descriptions, equipment in automatic mode shall be transitioned to manual mode (and stopped) if the equipment fails or becomes unavailable or if the PLC processor resets.

3-1.13. Manual/Auto Bumpless Transfer. Unless otherwise indicated in the equipment control descriptions, equipment changes from automatic to manual control shall be bumpless. Equipment running or stopped in automatic mode shall remain running or stopped when manual mode is selected.

3-2. HMI FUNCTIONAL REQUIREMENTS. The following paragraphs describe general configuration tasks that are required for the HMI and related software.

3-2.01. Database. The system database, including field I/O and internal points shall be established according to the database point naming conventions approved by Owner. Database generation for field I/O shall include all required coordination with PLC level addresses. If no Owner database point naming conventions are available, the database names shall utilize an ISA or ISA-like tag name.

In the default scheme, the format of the tag name is AAA-SSS-FFF-9999.

AAA is the Plant Area Code
SSS is the System Code
FFF is the ISA function designation.
9999 is the unique loop designation defined by the P&IDs.

Where possible 9999 will correspond to the loop numbers on the P&IDs. Otherwise, a unique number shall be assigned. For instance, if there are two ferric sulfate metering pumps and the loop numbers chosen are 0101 and 0201, the remote status input for pump number one would be 90-FES-YI-0101 and the remote status input for pump number two would be 90-FES-YI-0201.

Function designations currently defined are listed below:

AIs (Analog Inputs)

AI - Analytical Input	PDI - Differential Pressure Input (Headloss)
EI - Voltage Input	PI - Pressure Input
EII - VAR Input	SI - Speed or Rate Input
FI - Flow Input	TI- Temperature Input
II - Current Input	WI - Weight Input
JI - Power Input	ZI - Position Input
LI - Level Input	

AOs

AC - Residual Proportioning Control	SC - Speed or Rate Control
FC - Flow Proportioning Control	ZC - Position Control

DIs

AAH - Analytical Alarm High	PDAH - Differential Pressure Alarm High
AAL - Analytical Alarm Low	PA - Pressure Alarm High/Low or Unspecified
FAH - Flow Alarm High	PAL - Pressure Alarm Low
FAL - Flow Alarm Low	PALL - Pressure Alarm Low-Low (Cutoff)

YI - Event Indication (Hand Switch In Remote)	UA – Multivariable/Common Alarm/Common Fault or Unspecified
JA - Electrical Alarm	WAL - Weight Alarm Low
LAH - Level Alarm High	YA - Equipment General Alarm Event (Failure)
LAHH – Level Alarm High-High (Water Cutoff)	YIR - Equipment Run Status
LAL - Level Alarm Low	ZIC - Position Closed Status
LALL – Level Alarm Low-Low (Low Water Cutoff (LWCO))	ZIO - Position Open Status

DOs

LAL - PLC Generated LWCO Output	ZCC - Equipment Close Command
XC - General Control Output	ZCO - Equipment Open Command
UCR - Equipment Run/Start Command	
UCS - Equipment Stop Command	

Initially, the facility database shall be configured so all database points are defined as belonging to a specific area (as allowed by the graphical interface software). The areas designated for the facility shall be coordinated with Owner. If Owner has no existing standards for area designations, all points can be placed in appropriate areas selected by System Supplier.

3-2.02. Trend Displays. Trend displays shall be developed to present real-time and historical process data in an X-Y graph format. Real-time trends shall utilize current process values to generate temporary graphs that do not retain data values. Historical trends shall utilize historically collected data and shall access the data files directly for use in the trend display. Historical trends shall allow paging forward and back to the limits of the collected data. The trending package shall be configured to automatically retrieve historical data from the proper data file to accommodate the paging functions. Content of the trends shall be determined after meeting with Owner. Twenty-four (24) real-time trend displays and twenty-four (24) historical trend displays shall be provided.

3-2.03. Alarms. Complete system alarming shall be configured. This shall include configuration of graphical alarm displays, and configuration of audible alarms through the HMI speakers. All process or system alarms shall appear on an alarm summary screen and the alarm banner of each process graphic.

Alarms and events shall be color coded on the alarm summary screen, with initial colors based on Owner conventions or the default colors associated with the graphics package. The colors may be adjusted after meeting with Owner. Alarm prioritizing and area assignments (if any) shall be coordinated with Owner at the first configuration meeting.

For LOW or LOW-LOW analog or discrete alarms which do not apply if associated equipment is not operating, provisions shall be made to prevent/Lock generation of the alarm unless the associated equipment is operating. This shall include alarms such as low amperage alarms for pumps that are not running. This may also include low flows or pressures when associated pumps are not operating (this will only apply if periodic operation of the equipment is considered normal).

All alarms/events shall be time stamped when displayed or printed. Unacknowledged alarms shall not automatically clear from the alarm summary if they return to normal before being acknowledged.

3-2.04. Reporting. System reporting shall be accomplished using the standard operator interface software-reporting package. All necessary report development, including macro development in spreadsheets, shall be supplied to access real-time and historical data for reporting. Twelve (12) historical, monthly facility reports shall be provided to document compliance with the Owner's licensing requirements.

3-2.05. Historical Data Collection. System data shall be collected for historical archiving and for use in trending and reporting functions. Requirements for data collection shall be as needed to support the trends and reports developed.

3-2.06. Manual Entry of Data. The human machine interface (HMI) computers shall allow manual entry of laboratory data and other variables, which shall then be available for display and use in reports. Operator entered commands from any of the HMI computers shall be logged at all HMI computers.

3-3. EQUIPMENT CONTROL AND CONTROL MODE OVERVIEW. The following paragraphs explain the general format and control modes that are used in the detailed equipment descriptions. These paragraphs apply to the attached, project specific, equipment control descriptions included herein.

3-3.01. General. Appended to this section are the equipment control programming requirements, with requirements for both PLC programming and the minimum operator interface functions. The HMI requirements represent the anticipated display generation requirements and shall be adjusted if the PLC programming warrants adjustment.

3-3.02. Control Modes. There are two general plant control system (PCS) control modes available for the process equipment: 1) remote manual, and 2) remote auto. Remote manual control provides a means for operators to adjust equipment status or set point, through the HMI, using manually initiated commands. Remote automatic control provides a means for automatically changing equipment status or set point based on measured process parameters, calculated values, or operator set points. Some equipment may have more than one remote auto mode.

Descriptions for local control are included in the detailed equipment control descriptions. They are provided primarily for documentation purposes and for information. These controls are hardwired and require no programming effort.

3-3.03. Color Conventions. Equipment symbols, data values, alarm text and other objects shall change color based on event state, alarm or control action.

Description	**Color (white = 1,1)**
Active State, such as Running, Open	Green
Inactive State, such as Off, Closed	Red
Local Control in Field	Blue
Remote Control, via PCS	Dark Blue
Failed	Yellow
Equipment not monitored or controlled	Dark Gray

In the Alarm List critical equipment alarms are red and non-critical equipment alarms are yellow.

3-4. DETAILED EQUIPMENT CONTROL DESCRIPTIONS. The following paragraphs describe specific function requirements for various software control blocks in the control system. These descriptions are intended to provide an overview of the operational concept for the facilities, rather than describing in detail every operating feature or interlock.

3-4.01. CRITICAL CONTROL POINTS. The following process limits shall initiate alerts and alarms.

Process	Hazard/Credits assigned to barrier	Alert Level[1][3]	Alarm Level[2]
MBR	Virus – 1.0loglog Giardia – 2.5-log Cryptosporidium – 2.5-log	Turbidity > 0.15 NTU	Turbidity > 0.2 NTU – 95% within any 24 hour period. Not to exceed 0.5 NTU

Process	Hazard/Credits assigned to barrier	Alert Level[1][3]	Alarm Level[2]
RO	TOC LRV: Virus – 1.5-log Giardia – 1.5-log Cryptosporidium – 1.5-log Chemical Reduction (TOC) – 0.3 to 0.5 mg/L EC LRV: Virus – 1.0-log Giardia – 1.0-log Cryptosporidium – 1.0-log	TOC LRV < 2.0-log[5] TOC Permeate > 0.3 mg/L EC LRV < 1.50-log[5]	TOC LRV < 1.5-log TOC Permeate > 0.5 mg/L EC LRV < 1.0-log
NaOCl	Minimize NDMA formation	ORP – TBD Free Chlorine – TBD[4] Chloramines – TBD[4]	ORP – TBD[5] Free Chlorine – TBD[5] Chloramines – TBD[5]
UV	Virus – 6.0-log Giardia – 6.0-log Cryptosporidium – 6.0-log	UVT < 96% pH – TBD[4] Dose – TBD[4]	UVT < 95% pH – TBD[4] Dose – TBD[4]
NaOCl / Chloramination (UV/AOP)	Trace chemicals > 0.5-log	Free Chlorine Feed – TBD[4] Free Reduction – TBD[4] Chloramine Feed – TBD[4] Chloramine Reduction – TBD[4]	Free Chlorine Feed – TBD[4,6] Free Reduction – TBD[4,6] Chloramine Feed – TBD[4,6] Chloramine Reduction – TBD[4,6]
Calcite	Prevent corrosion and maintain groundwater chemistry	pH – TBD[4] EC – TBD[4]	pH – TBD[4] EC – TBD[4]

[1] No diversion will occur in case of exceedance of alert levels; monitoring system of process calibration/troubleshooting procedures in OOP will be followed.

[2] Water will be diverted in case of exceedance of alarm levels.

[3] For the first 6 months data will be collected to develop baseline performance and low level alarm will be set at 2 x standard deviation of baseline conditions.

[4] Values to be determined during startup.

[5] Values are anticipated, noting that DDW will conservatively permit TOC LRV at

1.5 and EC LRV at 1.0.
[6] Short term (time TBD) loss of AOP does not require diversion.

3-4.02. HEADWORKS – AREA 20. Flow enters the plant upstream of the packaged headworks. Flow is pumped from the existing wastewater treatment plant at sea level up to the new WRF (pump station by others), passes through flow meters (21-SCR-FE/FIT-0101 and 21-SCR-FE/FIT-0201) to measure influent flow and enters one of the two packaged headworks units. The smaller meter (21-SCR-FE/FIT-0201) is used under typical flow conditions. The larger meter (21-SCR-FE/FIT-0101) is used either in parallel or separately with the smaller meter during high-flow periods.

A packaged Headworks system consisting of coarse screen, vortex grit removal, and fine screen systems are dedicated to removing and processing suspended particulate matter. Coarse screening and grit removal are provided to all flow entering the plant. Two coarse screen and grit removal trains are provided, each able to treat up to the peak hour flows.

Influent (coarse) screening system serves as the first treatment step by removing and processing large debris, such as rags, paper, and plastics. Solids are captured on the bar screen rack, while water passes through the screen to the grit removal system. Intermittently, the solid screenings are collected from the racks and discharged to the coarse screening washer compactor. The washer uses plant water to remove soluble organics from the screenings and send them for treatment in downstream processes. A screw auger dewaters and conveys screenings into bag, then into a rolling dumpster for offsite disposal.

Wastewater from the coarse screens enters the grit basin where grit settles in the bottom of the basin and grit slurry is pumped to the separator, while the overflow rejoins the mainstream. The separator further concentrates the grit through centrifugal force. Carrier water and lighter organics exit the separator and return to the grit basins. The heavier grit falls into the grit classifier, where plant recycled water is used to wash organics from the grit. The settled grit is carried up an inclined screw auger, allowing the grit to dewater before falling into a grit hopper. The grit hopper discharges the grit into a rolling dumpster for offsite disposal. The washwater and organics overflow the classifier weir and are sent to the plant drain.

Screened and degritted wastewater enters the SAFE Box, which splits water between the fine screens and the SAFE system. Up to 1.88 mgd, the capacity of the MBR, flows by gravity to the fine screens. At flows exceeding 1.88 mgd, the flow control valve at the fine screens' influent regulates the flow, fills the SAFE Box. The overflow is sent to the SAFE settle tank that feeds the SAFE filter system by gravity once the SAFE settle tank is at capacity.

Train 1 fine screen or train 2 fine screen shall be selected from the plant control system, flow shall be diverted to the respective train via inlet modulating valves (21-SCR-V-1001 or 21-SCR-V-2001). High level alarm signal at mixed liquor collection chamber measured by 31- MEM-LIT-1001 and 2001 shall shut off flow going through the fine screens and shall be diverted to the Safe settle system.

3-4.02.01. Mechanically Cleaned Bar Screen. Local Control Panels (LCPs) are provided by the Headworks System supplier for independent control of each of the coarse screens and associated equipment. Control information provided herein is for information only and is a general description of operating philosophy. This description is subject to change based on the Headworks System suppliers' standards and operating approach.

The coarse screens may be operated in manual or automatic mode as described below. Details of the control are to be determined by the system supplier.

Associated Equipment
Course Screens (21-SCR-SCR-1001 and 21-SCR-SCR-2001)
Course Screen inlet valves (21-SCR-V-1001 and 21-SCR-V-2001)
Washer compactors (21-SCR-WCMP-1001 and 21-SCR-WCMP-2001)
Conveyors (21-SCR-COS-1001 and 21-SCR-COS-2001)

Associated PLC and RIO
21-SCR-PLC-1001, 21-SCR-PLC-2001, 80-CTRL-PLC-0101 and 0201, 21-CTRL-RIO-0001

Associated P&ID(s)
21-I-001, 21-I-002

Local Manual Mode
Local Manual control of the bar screen shall be provided through the bar screen local control panel (LCP). When the ON-OFF-AUTO (O-O-A) switch at the bar screen is in the ON position, the screen rake shall be controlled by momentary FORWARD and REVERSE push buttons at the screen.

In all control modes, the bar screen shall be interlocked to prevent operation if the water level in the channel rises and trips the high-high level float switch.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
Local automatic control of the bar screen shall be provided through the bar screen control panel. When the ON-OFF-AUTO (O-O-A) switch at the bar screen is in the AUTO position, the screen shall be controlled to rake when differential level across the screen increases and the high differential level switch trips or based on a panel mounted 24 hour programmed timer, whichever occurs first. When either initiating condition occurs, the bar screen control panel shall send a start signal to the screenings compactor to start. The bar screen shall be interlocked to start when an initiating condition occurs, and the screenings conveyor is running. The bar screen control panel shall control the raking operation and bring the rake back to the home position. When the raking action is complete, the bar screen control panel shall send a shutdown signal to the screenings conveyor. If the screenings conveyor stops while the bar screen is running, the bar screen shall complete the cleaning cycle, then stop. Refer to the mechanically cleaned bar screen specification for further details.

Alarms
The PLC shall receive a Bar Screen Fail, E-Stop and High-Level signals from the bar screen control panel. The Fail signal includes motor overload and over torque.

Status Indications
The HMI shall indicate the following bar screen status:
Bar Screen Running and Bar Screen Differential Level

PLC Powerup
The bar screen shall start the 24-hour timer upon power up.

Power Failure
N/A

HMI Requirements
The bar screen shall be depicted on the headworks display. The display layout shall be similar to the P&ID.

Calculations
Plant Total Influent Flow = 18” Influent Main Flow (21-SCR-FIT-0101) + 14” Influent Main Flow (21-SCR-FIT-0201)

3-4.02.02. Vortex Grit Basin.
Common Local Control Panels are provided by the Grit Removal System supplier for independent control of each of grit basin, separator/classifier, associated equipment for respective bar screen. Details of the control are to be determined by the Headworks System provider.

Associated Equipment
21-GRT-GRB-1001, 21-GRT-GRB-2001

Associated PLC and RIO
21-SCR-PLC-1001, 21-SCR-PLC-2001, 80-CTRL-PLC-0001, 21-CTRL-RIO-0001

Associated P&ID(s)
21-I-001, 21-I-002

Local Manual Mode
Local manual control of the grit basin drive shall be provided through the ON-OFF – Remote (O-O-R) selector switch mounted near the drive. When ON is selected, the drive shall run continuously.

Local Auto Mode
None.

Remote Manual Mode
Remote manual control shall be provided through the PLC. Operator shall select the train in operation as per MBR train, When the O-O-R selector switch near the drive is in the REMOTE position and MANUAL is selected at the plant control system.

Remote Auto Mode
None.

Alarms
None.

Status Indications
None.

PLC Powerup
N/A

Power Failure
N/A

HMI Requirements
The grit basin shall be depicted on the Plant Overview display with the current status indicated. The grit basin shall also be depicted on the grit system display. The display layout shall be similar to the P&ID.

The grit mixer run time for the current and previous days shall be depicted on the Run Time display.

Calculations
None.

3-4.02.03. Vortex Grit Basin Flushing Water Valve.

Associated Equipment
21-PRW-V-1002, 21-PRW-V-2002

Associated PLC and RIO
21-SCR-PLC-1001, 21-SCR-PLC-2001, 80-CTRL-PLC-0001, 21-CTRL-RIO-0001

Associated P&ID(s)
21-I-001, 21-I-002

Local Manual Mode
Local Manual control of the vortex grit basin flushing water valve shall be provided through the LOCAL-OFF-REMOTE (L-O-R) selector switch and OPEN-STOP-CLOSE (O-S-C) push buttons mounted near the valve. In the LOCAL position, the valve shall be operated using the OPEN-STOP-CLOSE push buttons.

Local Auto Mode
None.

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the L-O-R selector switch near the valve is in the REMOTE position and MANUAL is selected at the HMI, the valve shall be opened and closed from the HMI using manual operator commands.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the L-O-R selector switch near the valve is in the REMOTE position and AUTO is selected at the HMI, the valve shall open when a grit pumping cycle is initiated. The valve shall close after an adjustable time delay (operator selectable at the HMI from 0-120 seconds, initially set at 30 seconds).

Alarms
The PLC shall generate a Valve Fail alarm when the valve position switch indicates that the valve did not reach the commanded position within an adjustable (0-30 sec, initially set at X sec) time delay. The alarm shall be generated only when the valve is in remote mode.

Status Indications
The HMI shall indicate the following valve status:
Valve in Local/Remote, Valve Open, and Valve Closed.

PLC Powerup
On PLC powerup, control of the valve shall be set to remote manual mode.

Power Failure
Control of the valve shall resume with the control mode established prior to the power failure.

HMI Requirements
The vortex grit basin flushing water valve shall be depicted on the grit system display. The display layout shall be similar to the P&ID. The valve symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of control mode (manual/auto), manual valve control (open/close), valve open time adjustment, and shall duplicate status indication as shown on the main display.

Calculations
None.

3-4.02.04. Grit Pumps.

Associated Equipment
21-GRT-P-1001, 21-GRT-P-2001

Associated PLC and RIO
21-SCR-PLC-1001, 21-SCR-PLC-2001, 80-CTRL-PLC-0001, 21-CTRL-RIO-001

Associated P&ID(s)
21-I-001, 21-I-002

Local Manual Mode
Local manual control of the grit pump shall be provided through the ON-OFF-REMOTE (O-O-R) selector switch mounted next to the pump. When ON is selected the pump shall run continuously.

In all control modes, the grit pump shall have a hardwired interlock preventing operation of the pump if the duty dewatering screw is not running or if the seal water pressure is low and the seal water low pressure switch trips.

Local Auto Mode
None.

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the O-O-R selector switch at the pump is in the REMOTE position and MANUAL is selected at the OIT, the pump ON/OFF shall be controlled from the HMI using operator train selection or manual commands.

Remote Auto Mode
Remote auto control shall be provided through the PLC. When the O-O-R selector switch at the pump in the REMOTE position and AUTO is selected at the OIT, the pump shall run based on either in an operator selected mode of timed cycle operation or volume of treated water.

In either mode, the following steps take place for each grit extraction cycle:

- Water valves open for a set time to fluidize the grit and allow it to be pumped.
- The grit pumps turn on for an adjustable duration. The grit classifier starts simultaneously with the grit pump and stops after a set time period after the grit pump stops. The grit classifier high pressure spray is simultaneously with the grit classifier. The conveyor starts simultaneously with the grit pump and stops after a set time period after the grit pump stops.

Alarms
None.

Status Indications

- None.

PLC Powerup
On PLC powerup, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure. Timers shall resume timing from the time accumulated prior to power failure.

HMI Requirements
The grit pumps shall be depicted on the grit system display. The display layout shall be similar to the P&ID. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of control loop mode (In Service/Out of Service), control mode (manual/auto), manual pump control (start/stop), and timer set point entry. Adjustment of timer set points shall be available to the supervisor's security level.

The grit pump run time for current and previous days shall be depicted on the Run Time display.

Calculations
None.

3-4.02.05. Grit Classifier and Dewatering Screws.

Associated Equipment
21-GRT-CGR-1001, 21-GRT-CGR-2001

Associated PLC and RIO
21-SCR-PLC-1001, 21-SCR-PLC-2001, 80-CTRL-PLC-0001, 21-CTRL-RIO-0001

Associated P&ID(s)
21-I-001, 21-I-002

Local Manual Mode
Local manual control of the grit classifier and dewatering screw shall be provided through the ON-OFF-REMOTE (O-O-R) selector switch mounted near the classifier. When ON is selected the classifier shall run continuously.

In all control modes, the spray wash valve shall be hardwired interlocked to open when the dewatering screw is running.

Local Auto Mode
None.

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the O-O-R selector switch at the classifier is in the REMOTE position and MANUAL is selected at the HMI, the classifier ON/OFF shall be controlled from the HMI using operator train selection or manual commands.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the O-O-R selector switch at the classifier is in the REMOTE position and AUTO is selected at the HMI, the duty classifier shall start when a grit pumping cycle is initiated. The classifier shall shut down after an adjustable time delay following shut down of the grit pump. A selector switch shall be provided near the grit classifiers, to select the duty classifier.

Alarms
None.

Status Indications
None.

PLC Powerup
On PLC powerup, control of the dewatering screw shall be set to remote manual mode.

Power Failure
Control of the classifier shall resume with remote manual mode selected.

HMI Requirements
The grit classifier and dewatering screw shall be depicted on the grit system display. The classifier symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display contains control targets which allow selection of control loop mode (In Service/Out of Service), control mode (manual/auto) and manual dewatering screw control (start/stop).
The grit classifier run time for current and previous days shall be depicted on the Run Time display.

Calculations
None.

3-4.02.06. SAFE Box. The SAFE Box is located downstream of the headworks. It has adequate volume to allow the fine screen influent valve to adjust as needed to limit BNR/MBR system flow to that system's capacity. Any excess flow above that capacity overflows the SAFE Box weir to the SAFE System for treatment and Ocean Discharge.

Associated Equipment
21-SCR-LE/LIT-0001

Associated PLC and RIO
80-CTRL-PLC-0001, 21-CTRL-RIO-0001

Associated P&ID(s)
22-I-001

Local Manual Mode
N/A

Local Auto Mode
N/A

Remote Auto Mode
N/A

Alarms
The HMI shall indicate the following SAFE Box alarms:

- SAFE System Box Level High-High
- SAFE System Box Level High
- SAFE System Box Level Transmitter Fail

Status Indications
The HMI shall indicate the following SAFE Box status:

- SAFE Box Level

PLC Powerup
N/A

Power Failure
N/A

HMI Requirements
The SAFE System Box shall be depicted on the headworks display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.02.07. Packaged Fine Screen. The fine screening system removes trash and fibrous materials such as hair and paper to protect the membranes and prolong their life. Flow from the SAFE Box is regulated by a modulating flow control valve to the fine screens at a maximum flow of 1.88 mgd, the maximum capacity of the biological treatment system. The design consists of two identical fine screen and washer compactor trains, providing 100% redundancy. A conveyor is shared between the two trains.

Each fine screening train is comprised of a perforated plate drum screen and washer compactor. Floating and suspended materials is retained by the screen basket. The basket starts to rotate when a preset upstream water level exceeds due to screen surface blinding. The rotating screen drum lifts the screenings and drops them into a trough. Screenings removal from the drum is supported by a scraper brush and a spray nozzle bar. A screw conveyor in the trough rotates with the drum and transports, dewaters and compacts the screenings, and discharges them into a bag contained in a dumpster. Screened wastewater is combined in a pipeline that discharges to the BNR-MBR. Sodium hydroxide feed

system is provided to add alkalinity for pH control in the biological process, if necessary.

Flow from the SAFE Box is routed to one of the two fine screens by gravity. Effluent from the Fine Screens flows to the BNR System by gravity. The fine screen Influent is routed through a flow meter where it shall be controlled by a control valve upstream of the flowmeter to limit the flow to the MBR maximum capacity. Any excess flow above the fine screen capacity backs up in the SAFE Box and overflows the SAFE Box weir to the SAFE system.

Common Local Control Panel is furnished by the fine screen system supplier for independent control of each of the screens and associated equipment. Control information provided herein is for information only and is a general description of operating philosophy. This description is subject to change to conform to the system suppliers' standards and typical operating approach.

The screens may be operated in manual or automatic mode as described below. Details of the control are to be determined by the system provider.

Associated Equipment
Fine Screens (22-SCR-SCR-1101 & 22-SCR-SCR-1201)
Conveyor and Discharge Chute (22-SCR-COS-0001)

Associated PLC and RIO
80-CTRL-PLC-0001, 21-CTRL-RIO-0001

Associated P&ID(s)
22-I-001

Local Manual Mode
Local Manual control of the screen shall be provided through the combined fine screen control panel. When the HAND-OFF-AUTO (H-O-A) switch at the screen panel is in the HAND position, the screen shall be controlled by the push buttons at the screen control panel.

Local Auto Mode
Local automatic control of the screen shall be provided through the screen control panel. When the HAND-OFF-AUTO (H-O-A) switch at the bar screen is in the AUTO position, the screen shall be controlled as per the differential level across the screen. Floating and suspended materials shall be retained by the screen basket. The basket will start to rotate when a preset upstream water level exceeds due to screen surface blinding. The rotating screen drum will lift the screenings and drop them into a trough. Screenings removal from the drum is supported by a scraper brush and a spray nozzle bar. A screw conveyor in the trough will rotate with the drum and transports, dewaters and compacts the

screenings, and discharge them into a bag contained in a screening container. See the Fine screen specification for further detail.

Remote Manual Mode
Local control panel initiates operation of screen drum, washer/compactor, and conveyor. Operators manually select which unit(s) operate and leave them running continuously. Control valve utilizes flow meter to maintain the MBR treatment flow capacity, maximum flow of 1.88 mgd through the fine screens. The valve is controlled directly by the Plant PLC and can be remotely or manually set to a position.

Remote Auto Mode
Automatic screen operation is based on differential level and/or time.
For differential level control, the water level is measured upstream and downstream of each screen. The basket starts to rotate when a preset differential level is exceeded due to screen surface blinding. The rotating screen drum lifts the screenings and drops them into the centrally arranged trough. Screenings removal from the drum is supported by a scraper brush and a spray nozzle bar. Plant recycled water is supplied by solenoid valves. In the event plant recycled water pressure is low a pressure switch generates an alarm. A screw conveyor in the trough rotates with the drum and transports the screenings through a closed and inclined pipe. The conveying screw transports, dewaters and compacts the screenings, without any odor nuisance, and discharges them into the screening container. Screened wastewater is combined in a pipeline that discharges to the MBR.

For timer control, a programmable timer is used to initiate cleaning events. During periods of low flow, the rake may not reach levels high enough to trigger an event. A 24-hour programmable timer can be set to periodically operate the drum to ensure screenings stay fresh.

Washer compactor operation shall be interlocked with the drum screen.

The conveyor shall be integrated with the washer compactor. A time delay setting maintains the conveyor powered for a set time period after the compactor stops running.

Alarms
The PLC shall receive fine Screen trouble, High differential level and low spray wash pressure signal from the screen control panel and motor overload signal from conveyor control panel.

Status Indications
The HMI shall indicate the following bar screen status:
Fine Screen In Auto, Running fast, Running Slow
Conveyor in Remote, Running, Zero speed signal.

PLC Powerup
N/A

Power Failure
N/A

HMI Requirements
The Fine screens shall be depicted on the headworks display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.02.08. Packaged Odor Control System. Odor control is provided to treat the foul air from the headworks, the headspace of the fine screens, SAFE Box, grit basin, and coarse screens and channels. The biofilter system draws foul air from the headworks via the odor control fan and provides two-stage treatment within the modular biofilter vessel (humidification and odorant removal). The odor control system is comprised of the following key elements: foul air piping to convey the foul air from headworks to the odor control facility; pre-filter for grease and moisture removal; foul air fan; packaged two-stage biofilter; and damper(s) to isolate and balance airflow.

The system operates with counter-current flow. Plant water, with nutrients as required during startup, continuously added to the system to serve as makeup water and irrigation water. The first stage humidification uses a recirculation pump to recirculate the solution through a sump into the spray-down nozzles, providing some level of H2S removal. The second stage is irrigated to wet the media for target odorant removal. The odor control system is intended to operate continuously.

The Odor Control system shall be operated in manual or automatic mode as described below. Control information provided herein is for information only and is a general description of operating philosophy. This description is subject to change to conform to the system suppliers' standards and typical operating approach. Details of the control are to be determined by the system provider.

Associated Equipment
Odor Control Fan no.1 (23-ODC-FAN-0001)
Odor Scrubber No.1 (23-ODC-SCU-0001)
Recirculation Pump (23-ODC-P-0001)

Associated PLC and RIO
80-CTRL-PLC-0001, 21-CTRL-RIO-0001

Associated P&ID(s)
23-I-001

Local Manual Mode
Local Manual control of the system shall be provided through the Odor system local control panel.

Local Auto Mode
None.

Remote Manual Mode
When selected in Remote mode Odor control system shall be initiated from the plant control system when is headworks is controlled remotely.

Remote Auto Mode
None.

Alarms
The PLC shall receive Odor control system Fail signal from the local control panel.

Status Indications
The HMI shall indicate the following Odor control system status:
Odor control system Running, In- Remote indication

PLC Powerup
On PLC powerup, control of the system shall be set to remote manual mode.

Power Failure
Control of the system shall resume with remote manual mode selected.

HMI Requirements
The Odor control system shall be depicted on the headworks display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.03. BIOLOGICAL NUTRIENT REMOVAL SYSTEM – AREA 30.

The components in the treatment area provide biological treatment and filtration of the influent wastewater. The biological nutrient removal (BNR) system treats carbon and nitrogen in the fine screened wastewater through the Modified Ludzack-Ettinger (MLE) biological process. Mixed liquor from these basins is pumped to the Membrane Bioreactor (MBR) system which provides additional

aerobic biological treatment and microfiltration. The combined BNR-MBR system produces effluent water supply suitable for feeding the RO system, supplying the plant recycled water system, and discharging to the ocean.

High level alarm signal at mixed liquor collection chamber measured by 31-MEM-LIT-1001 and 2001 shall shut off flow going through the fine screens and shall be diverted to the Safe settle system.

The BNR system is comprised of two identical treatment trains with a common deoxygenation zone and splitter zone. Screened wastewater from the fine screens and return activated sludge (RAS) from the deoxygenation zone is combined at the mixing chimney, which is contained within the splitter zone. From the splitter zone, the combined flow is split between two identical biological treatment trains.

The first zone of the trains is anoxic to support denitrification. Mixing is provided in the deoxygenation and anoxic zones by submersible mixers.

MLSS from the anoxic zone is directed over a weir to the aerobic zone for nitrification and carbon oxidation. The aerobic zone consists of two fine bubble diffuser grids to support independent DO control between the front and end halves of the aeration basins. Mixed liquor flows into a channel at the end of each train, where MLSS is pumped to a common header and then split among two MBR membrane tanks. The common pipe header allows flexibility in MBR basin use. The MBR concentrates the biomass, which is directed to the RAS channel to be wasted or returned to the deoxygenation zone.

The blowers use compressed air for injection into the MBR aeration zones to maintain aerobic biological activity.

Biomass and scum are removed through multiple means. Scum and MLSS (i.e., surface WAS) flow over a submerged weir at the end of each aerobic basin. Within the channels at the end of each aerobic basin, there are additional submerged weirs which send scum to a collection box. Each collection box has a pipe and a motorized valve. The valve shall be programmed to open for surface wasting and draw scum off the top. This Scum is sent to the Scum/WAS wetwell. Additionally, WAS is wasted from the RAS Deox pipeline with a pump and flow meter. The Scum/WAS Wetwell contains the option for foam spray. Two pumps are provided, one dedicated to pumping WAS directly to the sludge holding tanks and one dedicated to pumping out of the scum/WAS tank. The combined scum and WAS are pumped to a common manifold that is metered and sent to the Sludge Holding Tanks.

Associated Equipment and Instrumentation

BNR RAS DeOx Mixer	31-RAS-MXR-0001
BNR Splitter Box pH	31-BNR-AIT-0001
BNR # 1 System	
BNR # 1 Anoxic Zone ORP	31-BNR-AIT-1001
BNR # 1 Anoxic Zone Mixer	31-BNR-MXR-1001
BNR # 1 Aerobic Zone 1 Dissolved Oxygen	31-BNR-AIT-1101
BNR # 1 Aerobic Zone 1 Air Flow Meter	31-BNR-FIT-1101
BNR # 1 Aerobic Zone 1 Air Flow Control Valve	31-AER-V-1101
BNR # 1 Aerobic Zone 2 Dissolved Oxygen	31-BNR-AIT-1201
BNR # 1 Aerobic Zone 2 Air Flow Meter	31-BNR-FIT-1201
BNR # 1 Aerobic Zone 2 Air Flow Control Valve	31-BNR-AER-V-1201
BNR # 1 Aerobic Zone 2 MLSS	31-BNR-AIT-1002
BNR # 1 Aerobic Zone 2 Ammonia-N	31-BNR-AIT-1003
BNR # 1 Surface Wasting Valve	31-WAS-V-1001
BNR # 1 MBR Feed Pump	31-BNR-P-1001
BNR #1 Mixed Liquor Collection Channel Level	31-MEM-LIT-1001
BNR #1 Scum Collection Box To WAS Wetwell ISO	31-BNR-V-1001
BNR # 2 System	
BNR # 2 Anoxic Zone Mixer	BNR-MXR-2001
BNR # 2 Aerobic Zone 1 Dissolved Oxygen	31-BNR-AIT-2101
BNR # 2 Aerobic Zone 1 Air Flow Meter	31-BNR-FIT-2101
BNR # 2 Aerobic Zone 1 Air Flow Control Valve	31-AER-V-2101
BNR # 2 Aerobic Zone 2 Dissolved Oxygen	31-BNR-AIT-2201
BNR # 2 Aerobic Zone 2 Air Flow Meter	31-BNR-FIT-2201
BNR # 2 Aerobic Zone 2 Air Flow Control Valve	31-AER-V-2201
BNR # 2 Aerobic Zone 2 MLSS	31-BNR-AIT-2002
BNR # 2 Aerobic Zone 2 Ammonia-N	31-BNR-AIT-2003
BNR # 2 Surface Wasting Valve	31-WAS-V-2001
BNR # 2 MBR Feed Pump	31-BNR-P-2001
BNR #2 Mixed Liquor Collection Channel Level	31-MEM-LIT-1002
BNR #1 Scum Collection Box To WAS Wetwell	31-BNR-V-2001
RAS Suspended Solids Meter	31-RAS-AIT-0001
BNR WAS Flowmeter	31-WAS-FIT-0001
BNR WAS and Surface Waste Combined Flowmeter	31-WAS-FIT-0002
BNR Scum/WAS Wetwell Level Transmitter	31-WAS-LIT-0001
BNR Scum/WAS Wetwell High-High Level Switch	31-WAS-LSHH-001
BNR Scum/WAS Pump	31-SCM-P-0001

BNR WAS Pump	31-WAS-P-0001
BNR Scum/WAS Wetwell Level Low-Low	31-WAS-LSLL-0001
PRW system ISO Valve	31-PRW-V-0002

Associated PLC and RIO
80-CTRL-PLC-0001, 31-CTRL-RIO-0001

Associated P&ID(s)
31-I-001, 31-I-002, 31-I-003

3-4.03.01. BNR System Mixers. The mixers shall be operated in Manual or Remote modes as described below. The mixer shall stop in any mode upon moisture detection or motor winding high temperature. The mixer status shall be displayed at the plant control system.

Local Manual Mode
Start/stop is provided by a selector switch at the Mixer. In local mode, the mixer runs continuously until the STOP button is pushed.

Local Auto Mode
None.

Remote Manual Mode
When selected in Remote mode the mixers shall be started/stopped from the PCS as per the train selection.

Remote Auto Mode
The mixer on/off is controlled from the plant control system.

When in Remote auto mode, the mixer shall be controlled using operator adjustable set-points for the interval between mixer operation and duration of mixer operation.

Alarms
The PLC shall receive mixer fail signal from the local starter panel.

Status Indications
The HMI shall indicate the following status:
Anoxic mixer Running, In- Remote indication

PLC Powerup
On PLC powerup, control of the mixer shall be set to remote manual mode.

Power Failure
Control of the mixer shall resume with remote manual mode selected.

HMI Requirements
The Anoxic mixer shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.03.02. BNR System Supplemental Alkalinity Addition. Alkalinity (sodium hydroxide) is dosed following fine screening based on an operator adjustable pH target and the measured pH in the BNR splitter box.

Local Manual Mode
None.

Local Auto Mode
None.

Remote Manual Mode
When selected in Remote mode the dosing pump on/off and operator adjustable speed are controlled from the plant control system.

Remote Auto Mode
When in Remote auto mode, process control shall be used to maintain the pH in the BNR aerobic zone at an operator adjustable acceptable set point.

Alarms
The PLC shall receive pH instrument Fail signal from the pH analyzer.

Status Indications
None.

PLC Powerup
None.

Power Failure
None.

HMI Requirements
The BNR splitter box shall be depicted on the BNR display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.03.03. BNR Aeration Control. Aeration Control shall be achieved using Local or Remote modes as described below. Local Manual and Remote Manual modes are primarily designed for troubleshooting and valve evaluation operations.

Local Manual Mode
In local mode, the valves controlling each aeration grid shall be operated using open-close-stop switches mounted on the valve actuators.

Local Auto Mode
None.

Remote Manual Mode
In remote manual mode, the valve position shall be controlled from the plant control system.

Remote Auto Mode
When in Remote auto mode, two air flow control modes are available. The aeration control mode can be selected by the operator from the plant control system. The air flow control valve to each drop-leg shall be controlled based on the operator selected DO control mode.

- Fixed DO control mode
  - Feedback process control maintains a continuous, uniform DO set point in each aerobic zone. The DO set point shall be operator adjustable at the plant control system.
  - DO Set points for Aerobic Zones 1 and 2 in each BNR System are:
    - AX.SWING (i.e., DO = 0) or
    - A value in the range of $DO_{AE\text{-}MIN}$ and $DO_{AE\text{-}MAX}$, indicated in Table 3-4.03.01.

    Table 3-4.03.01. Min and Max Values for Aerobic Zone DO Set Points in Fixed DO Control Mode

Min Operator Selectable DO Set Point	$DO_{FDO.AE\text{-}MIN}$	0.3 mg/L
Max. Operator Selectable DO Set Point	$DO_{FDO.AE\text{-}MAX}$	2.0 mg/L

  - When AX.SWING mode operation is selected (i.e., DO Set point = 0). The aeration is turned on intermittently based on the operator adjustable timer

set points indicated in Table 3-4.03.02. In this mode, the air flow shall be the minimum air flowrate.

Table 3-4.03.02. Operator adjustable intermittent aeration operation in AX.SWING (i.e., DO=0 mg/L)

Interval between aeration events	$T_{AIR\text{-}BUMP.INT}$	30 – 360 min
Duration of aeration event	$T_{AIR\text{-}BUMP.ON}$	1 – 5 min

The following apply to ALL Modes:

- A minimum and maximum total airflow is maintained. These limits are required to keep the blowers in their operating range through seasonal variations. The minimum and maximum air flow for each blower shall be operator adjustable (with password) at the plant control system, initially set at 60% and 100% respectively of each blower's capacity.
- While control is inhibited, all controller resets shall be inhibited to prevent reset windup.
- If at minimum airflow for greater than an operator entered set point time, the airflow set point from the PIDs above shall be overridden and the airflow shall be set at the mixing air flow for an operator entered set point time.
  - While the lag blower is starting or stopping, the position of the air flow control valves shall be maintained until an adjustable time following startup or shut-down of the lag blower.

Alarms
The PLC shall receive DO, MLSS, NH3/NH4 instrument fail signal from the DO, MLSS, NH3/NH4 analyzer.

Status Indications
Air control valve In Remote indication.

PLC Powerup
On PLC powerup, control system shall be set to remote manual mode.

Power Failure
Control system shall resume with remote manual mode selected.

HMI Requirements
The aerobic zone shall be depicted as a separate display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.03.04. MBR Feed Pumps. MBR Feed Pumps can be operated in Local and Remote modes as described below. Local and Remote-Manual modes are primarily for equipment verification and testing. The normal control mode is Remote-Auto mode managed from the plant control system.

Local Manual Mode
The MBR Feed Pump can be Started and Stopped using the Local Control Station in the field. The pump speed is managed from the VFD. The pump runs continuously until the STOP button is pushed or hard-interlocks result in the pump being stopped (High motor temperature, High moisture detected and low level in the MBR Feed Channel).

Local Auto Mode
None.

Remote Manual Mode
In remote manual mode the pump operation and speed are controlled from the plant control system to maintain target flow or level in the MBR basin.

Remote Auto Mode
The MBR Feed Pumps are controlled to maintain a target flow set point. The set point is based on the sum of RAS flow and Fine Screen Influent flow.

Alarms
The PLC shall receive VFD fault signal from the VFD panel.

Status Indications
MBR Feed pump In Remote indication.

PLC Powerup
On PLC powerup, control system shall be set to remote manual mode.

Power Failure
Control system shall resume with remote manual mode selected.

HMI Requirements
The MBR feed pumps shall be depicted on display. The display layout shall be similar to the P&ID.

Calculations
MBR Feed Pump Flow Set Point = RAS Flow + Fine Screen Influent Flow

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3-4.03.05. SRT and Wasting Management. SRT management in the BNR-MBR system is affected through controlled WAS wasting (from the RAS piping) and

Mixed Liquor Surface Wasting (from the BNR tanks). These systems are described here. Note that in accordance with expressed operator preferences, no automated SRT control is incorporated.

3-4.03.05.01. Waste Activated Sludge Wasting from RAS.

Local Manual Mode
The Waste Activated Sludge (WAS) Pump can be manually controlled at the pump.

Local Auto Mode
None.

Remote Manual Mode
In remote manual mode the pump operation and speed are controlled from the plant control system.

Remote Auto Mode
Two WAS wasting control modes are available. The mode of operation is operator adjustable at the plant control system.

- Fixed WAS Flow Set Point
  - Feedback process control maintains a continuous, uniform WAS flowrate.
- Daily WAS Volume Set Point
  - Feedback process control determines the required WAS flowrate to achieve the operator target 24-hour wasting volume.

The flow and daily total volume of WAS is monitored and recorded.

Alarms
The PLC shall receive VFD fault signal from the VFD panel.

Status Indications
WAS or Scum pump In Remote indication.

PLC Powerup
On PLC powerup, control system shall be set to remote manual mode.

Power Failure
Control system shall resume with remote manual mode selected.

HMI Requirements
The WAS and SCUM pumps shall be depicted on display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.03.05.02. Mixed Liquor Surface Wasting.

Local Manual Mode
The surface wasting valve for each BNR system can be operated locally from the valve actuator.

Local Auto Mode
None.

Remote Manual Mode
The surface wasting valve for each BNR system can be operated from the plant control system.

Remote Auto Mode
- In remote auto mode, the surface wasting valve in each BNR system is operated intermittently based on the operator adjustable timer set points indicated in table below. Default values shall be pre-programmed as part of startup/commissioning.

Table 3-4.03.03. Operator adjustable surface wasting operation

Interval between surface wasting events	$T_{SURFWAS.INT}$	30 – 360 min
Duration of surface wasting	$T_{SURFWAS.ON}$	1 – 5 min

- If the high-high level is reached in the WAS/Scum wet well, the surface wasting valve schedule is ignored (i.e., additional wasting does not occur) until the high-high level signal is eliminated. The flow and daily total volume of mixed liquor wasted from both BNR systems is monitored and recorded.

Alarms
None.

Status Indications
Valve In-Remote indication.

PLC Powerup
On PLC powerup, control system shall be set to remote manual mode.

Power Failure
Control system shall resume with remote manual mode selected.

HMI Requirements
The wasting valve arrangement shall be depicted on display similar to the P&ID.

Calculations
None.

3-4.03.06. Monitoring the BNR Systems. The data shown in Table 3-4.03.04 shall be continuously monitored and recorded at the plant control system for each BNR System.

Table 3-4.03.04. BNR System Monitoring Data at the plant control system

Subsystem	Parameter(s)	Statistics Provided
BNR Splitter Box	pH	▪ Daily 15-min MIN, Hourly Min ▪ Daily Average, Daily 15-min MAX, Hourly Max
BNR Systems 1 & 2	Status	▪ Operational Not Operational
	Inventory (also total system Inventory)	▪ Current Value (using 15-min avg. MLSS) ▪ Daily Average (calculated) ▪ 3-day Rolling Average 7-day Rolling Average
Zone 1	DO	▪ Current Value (15-min rolling avg.) ▪ Daily 15-min MIN, Hourly Min ▪ Daily Average, Daily 15-min MAX, Hourly Max

Subsystem	Parameter(s)	Statistics Provided
Zone 2	DO, MLSS, NHx-N	▪ Current Value (15-min rolling avg.) ▪ Daily 15-min MIN, Daily Average, Daily 15-min MAX, Hourly Max
RAS	Status	RAS Mode
	Flow, RAS.SS	▪ Current Value (15-min rolling avg.) ▪ Daily 15-min MIN, Hourly Min ▪ Daily Average, Daily 15-min MAX, Hourly Max
WAS	Status	Wasting Mode & related Set Points
	Flow, Inventory	▪ Current Value ▪ Daily 15-min MIN, Hourly Min ▪ Daily Average, Daily 15-min MAX, Hourly Max

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3-4.03.07. BNR Process Aeration Blower Control. BNR blower units (3 units) are provided which work in 2 duty/1 standby fashion to maintain the BNR process air header pressure. Blowers shall be locally controlled by vendor supplied individual LCPs and remotely from the Plant Control system. In all control modes, the blower shall be hardwired interlocked and shall shutdown on high inlet differential pressure, high discharge temperature or high discharge pressure.

Associated Equipment and Instrumentation.

Process Air Blower # 1	31-AER-BL-0101
Process Air Blower # 2	31-AER-BL-0201
Process Air Blower # 3	31-AER-BL-0301
Process Aeration Header Pressure	31-AER-PIT-0001

Associated PLC and RIO
80-CTRL-PLC-0001, 31-CTRL-RIO-0001

Associated P&ID(s)
31-I-004

Local Manual Mode
Individual blowers shall be Started and Stopped locally when Local is selected using the LOR switch mounted on the Local Control Station in the field. The blower speed is adjustable from the VFD in the local control panel. The blower runs continuously until the STOP button is pushed or hard-interlocks result in the blower being stopped (high inlet differential pressure, high discharge temperature or high discharge pressure).

Local Auto Mode
None.

Remote Manual Mode
Individual blowers shall be Started and Stopped using operator manual commands from plant controls system when Remote is selected using the LOR switch mounted on the Local Control Station in the field. Blower speed shall be adjusted based on the speed input entered at the plant control system.

Remote Auto Mode
Blowers shall be operated from the plant controls system to maintain the discharge header pressure when Remote is selected using the LOR switch mounted on the Local Control Station in the field. Duty rotation of the blowers shall be managed as per blower continuous running operation. Duty shall be swapped accordingly.

Blower is controlled by a PI type control function to maintain a pressure control set point in the process aeration header. The pressure set point shall be operator adjustable (with a password). A default value shall be pre-programmed during startup/commissioning.

A most open valve (MOV) algorithm is employed that selects the most open valve which is used to control the adjustment (see items 4 and 5 below) of the process aeration header pressure set point (see item 1 below).

1. The lead blower runs continuously with the speed controlled by a pressure controller, to maintain a pressure set point.
2. As demand increases and total air flow demand remains at the maximum for an operator-adjustable time period, a lag blower starts. Once running, the lead and lag blowers modulate together to maintain the set point discharge header pressure.
3. The blower speed modulates to control header pressure to maintain the set point. When the total air flow demand falls below the capacity of the lead blower for an adjustable period of time, the lag blower shutdown is initiated. Once the lag blower has shut down, the speed of the lead blower is controlled to maintain the set point pressure.

4. If the position of the most open basin air flow control valve exceeds an operator entered maximum position, the set point header pressure increases 0.1 PSI. This requires the air flow control valve to travel toward the closed position to maintain the set point airflow. The system stabilizes for an operator adjustable time period. If the valve remains above the maximum set point position, another increase of 0.1 PSI to the air pressure set point is made.
5. If the position of the most open air flow control valve becomes less than the operator entered minimum position, the set point header pressure decreases 0.1 PSI. This requires the air flow control valve to travel toward the open position to maintain the set point airflow. The system stabilizes for an operator adjustable time period. If the valve remains at a position less than the minimum position, another decrease of 0.1 PSI to the air pressure set point is made.

Alarms
The PLC shall receive blower fault signal from the VFD panel.

Status Indications
Blower Running, In Remote indication.

PLC Powerup
On PLC powerup, control system shall be set to remote manual mode.

Power Failure
Control system shall resume with remote manual mode selected.

HMI Requirements
The BNR process blowers shall be depicted on display similar to the P&ID.

Calculations
None.

3-4.03.08. MBR System. Mixed liquor effluent from each BNR train is pumped to a common MLSS header pipe. The MBR feed pumps feed the MBR trains and drive RAS flow return to the front of the BNR train. The membranes filter the inorganics and organics larger than the membrane pore size and provide a degree of pathogen removal. MBR Filtrate is sent to the RO Feed Tank. The remaining flow exits the MBR basins over the RAS weir. From the RAS weir channel, the water is sent to the Deox Tank and back to the head of the BNR process. WAS is wasted from the RAS pipe via flow control pump. The MBR system components include membrane cassettes, filtrate pumps, coarse bubble diffuser grids and dedicated blowers, drain pump and a Clean-In-Place system. To maintain performance, the MBR membranes are cleaned through both

physical and chemical means, including aeration, maintenance and recovery cleans by an acid (citric acid) and/or base (sodium hypochlorite).

Mixed liquor is pumped to the MBR system via a pipe manifold. Flow is split between the MBR trains by controlling the flow out of the MBR trains (either by controlling Membrane Filtrate flow via the Filtrate Pumps, or by a fixed RAS outlet weir for each train). Membrane Filtrate is routed to the RO Feed Tanks where it is distributed to the RO System or Recycled Water Pump Station. Excess flows passively overflow by gravity to the Outfall Pump Station to be pumped to the Ocean Outfall.

MBR train 1 and 2 selection shall be available from the plant control system in Manual or Auto mode, accordingly respective Headworks, RO, UV train shall be online accordingly.

MBR System Control Overview.
The MBR System shall be managed by the MBR System Suppliers standard controls and logic. Control information provided herein is for information only and is a general description of the operating strategy of the system. This description is subject to change to conform to the MBR system suppliers' standards and typical operating approach. The MBR System Controls will manage the following sub-systems:

- MBR Basin Operation Management;
- MBR Filtrate Pumps;
- MBR Air Scour; and
- MBR Cleaning (maintenance and recovery) Operations.
- RAS Channel Level control

Associated Equipment and Instrumentation

BNR # 1 MBR Feed Pump	32-BNR-P-1001
BNR # 2 MBR Feed Pump	32-BNR-P-2001
MBR Basin # 1	
MBR Basin # 1 Isolation Valve	32-MEM-V-1001
MBR Basin # 1 Drain Isolation Valve	32-DRN-V-0001
MBR Basin # 1 Level	32-MEM-LIT-1001
MBR Basin # 1 Low-Low Level Switch	32-MEM-LSLL-1001
MBR Basin # 1 High-High Level Switch	32-MEM-LSHH-1001
MBR Basin # 1 Sodium Hypochlorite Isolation Valve	32-NOCL-V-1001
MBR Basin # 1 Citric Acid Isolation Valve	32-CA-V-1001
MBR Basin # 1 Scour Air Isolation Valve	32-AIR-V-1001
MBR Basin # 1 Filtrate Pump	32-MEM-P-1001

MBR Basin # 1 Filtrate Flowmeter	32-MEM-FIT-1001
MBR Basin # 1 Filtrate Turbidity	32-MEM-AIT-1001
MBR Basin # 1 RAS Channel Level	32-RAS-LIT-1002
MBR Basin # 1 RAS Channel Level Control Valve	32-RAS-V-1001
MBR Basin # 1 RAS Flowmeter	32-RAS-FIT-1001
MBR Basin #1 Filtrate Pump Inlet Valve	32-MEM-V-1005
MBR Basin #1 CIP Solution Valve	32-MEM-V-1006

MBR Basin # 2

MBR Basin # 2 Isolation Valve	32-MEM-V-2001
MBR Basin # 2 Drain Isolation Valve	32-DRN-V-0002
MBR Basin # 2 Level	32-MEM-LIT-2001
MBR Basin # 2 Low-Low Level Switch	32-MEM-LSLL-2001
MBR Basin # 2 High-High Level Switch	32-MEM-LSHH-2001
MBR Basin # 2 Sodium Hypochlorite Isolation Valve	32-NOCL-V-2001
MBR Basin # 2 Citric Acid Isolation Valve	32-CA-V-2001
MBR Basin # 2 Scour Air Isolation Valve	32-AIR-V-2001
MBR Basin # 2 Filtrate Pump	32-MEM-P-2001
MBR Basin # 2 Filtrate Flowmeter	32-MEM-FIT-2001
MBR Basin # 2 Filtrate Turbidity	32-MEM-AIT-2001
MBR Basin # 2 RAS Channel Level	32-RAS-LIT-2002
MBR Basin # 2 RAS Channel Level Control Valve	32-RAS-V-2001
MBR Basin # 2 RAS Flowmeter	32-RAS-FIT-2001
MBR Basin # 2 Filtrate Pump Inlet Valve	32-MEM-V-2005
MBR Basin # 2 CIP Solution Valve	32-MEM-V-2006

BNR-MBR System Drain Pump	32-DRN-P-0001
BNR-MBR System Drain Pump Flowmeter	32-DRN-FIT-0001
MBR Filtrate Ammonia-Nitrogen	32-MEM-AIT-0001
MBR Filtrate Turbidity	32-MEM-AIT-00012
MBR System Air Scour Blower # 1	32-AIR-BL-0101
MBR System Air Scour Blower # 2	32-AIR-BL-0201

Associated PLC and RIO

32-MBR-PLC-001

Associated P&ID(s)
32-I-001, 32-I-002, 32-I-003, 32-I-004,32-I-005, 32-I-006, 32-I-007, 32-I-008

3-4.03.08.01. MBR System Basin Operation Management. The number of MBR Basins in Operation shall be determined based on the following inputs:

- BNR-MBR System influent flow which is measured using 22-SCR-FIT-1001 + 22-SCR-FIT-2001.
- The operational limits placed on the Membrane Cassettes by the Membrane System Supplier (e.g., Transmembrane Pressure, Operating Flux). This is determined and set by the Membrane System Supplier;
- Mechanical and System constraints of equipment (e.g., minimum pump flowrates).

An overview of the MBR Basin Operation Management strategy applicable to Morro Bay WRF is shown in Figure 3-4.03.01.

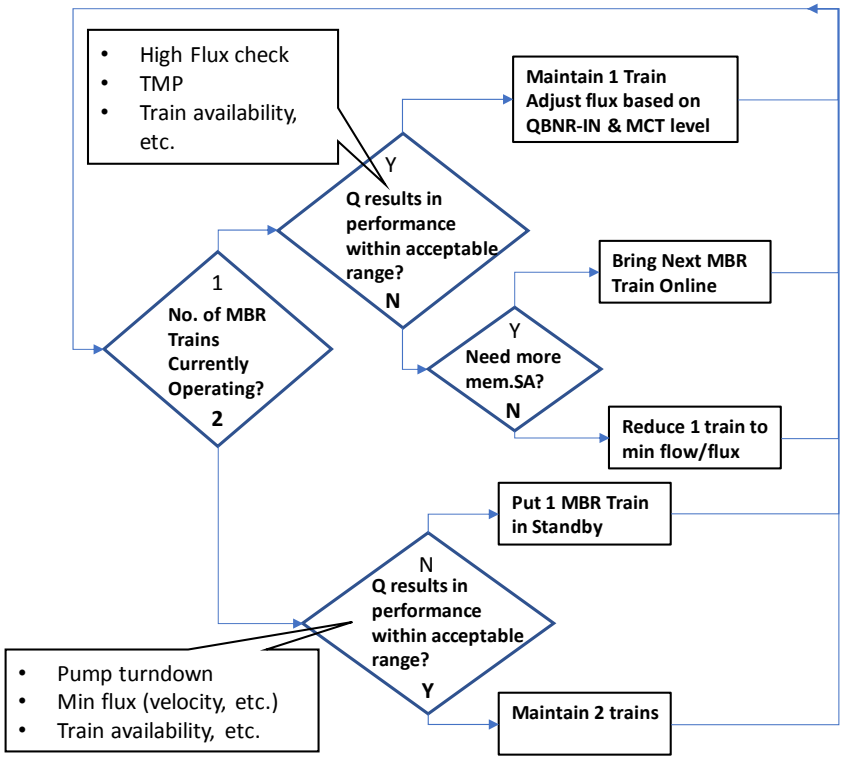

Figure 3-4.03.01. Overview of MBR System Basin Operation Management

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3-4.03.08.02. MBR Filtrate Pumps Control. MBR Filtrate Pumps can be operated in Local and Remote modes as described below. Local and Remote-Manual modes are primarily for equipment verification and testing. The normal control mode is Remote-Auto mode managed by the MBR System PLC.

Local Manual Mode
The MBR Filtrate Pump can be Started and Stopped using the Local Control Station in the field.

The pump speed is managed from the VFD.
The pump runs continuously until the STOP button is pushed or hard-interlocks result in the pump being stopped (High motor temperature, High and low discharge pressure).

Local Auto Mode
None

Remote Manual Mode
In remote manual mode the pump operation and speed are controlled from the plant control system to maintain target level in the MBR basin.

Remote Auto Mode
In Remote-Auto mode, the total filtrate flow is determined based on the BNR-MBR System influent flow which is measured using 22-SCR-FIT-1001 + 22-SCR-FIT-2001 (c.f., Section 3-4.01.04 above) using Equation (3).

The Filtrate to Influent Factor (FtoI_Factor) shown in Equation (3) is an operator adjustable (with password) flow correction factor (0.00 to 1.00, typical value in the range of 0.98 – 1.00) which allows the operations staff to set a target flow relative to the flow into the BNR-MBR system. The initial and typical value for this factor shall be pre-programmed during startup/commissioning.
The Filtrate Flow per MBR basin in operation is calculated as shown in Equation (4).

$$Total\ MBR\ Filtrate\ Flow\ Set\ Point, Q_{MBR.FILT-TOT} = Q_{SCR-FIT-1001} * FtoI\_Factor \quad (3)$$

$$MBR\ Basin\ Filtrate\ Flow\ Set\ Point, Q_{MBR.FILT-BASIN} = \frac{Q_{MBR.FILT-TOT}}{N_{MBR-BASINS}} \quad (4)$$

Alarms
The PLC shall receive VFD fault signal from the VFD panel.

Status Indications
MBR Filtrate pump In Remote indication.

PLC Powerup
On PLC powerup, control system shall be set to remote manual mode.

Power Failure
Control system shall resume with remote manual mode selected.
HMI Requirements
The MBR filtrate pumps shall be depicted on display similar to the P&ID.

Calculations
None

3-4.03.08.03. MBR Air Scour. MBR Air Scour Blowers can be operated in Local and Remote modes as described below. Local and Remote-Manual modes are primarily for equipment verification and testing. The normal control mode is Remote-Auto mode managed by the MBR System PLC.

Associated PLC and RIO
32-MBR-PLC-001

Associated P&ID(s)
32-I-006

Local Manual Mode
Individual blowers shall be Started and Stopped locally when Local is selected using the LOR switch mounted on the Local Control Station in the field.

The blower speed is adjustable from the VFD in the local control panel.
The blower runs continuously until the STOP button is pushed or hard-interlocks result in the blower being stopped (high differential pressure, high discharge temperature or low discharge flow).

Local Auto Mode
None

Remote Manual Mode
Individual blowers shall be Started and Stopped using operator manual commands from plant controls system when Remote is selected using the LOR switch mounted on the Local Control Station in the field. Blower speed shall be adjusted based on the speed input entered at the plant control system.

Remote Auto Mode
In Remote-Auto mode (which is the typical mode of operation) – the MBR Air Scour Function is managed by the MBR System Supplier based on the Suppliers' Specific scouring algorithm.

Alarms
The PLC shall receive blower fault signal from the local panel.

Status Indications
Blower Running, In Remote indication.

PLC Powerup
On PLC powerup, control system shall be set to remote manual mode.

Power Failure
Control system shall resume with remote manual mode selected.

HMI Requirements
The MBR process blowers shall be depicted on display similar to the P&ID.

Calculations
None.

3-4.03.08.04. Membrane Cleaning System. MBR Cleaning cycles are manually initiated by the operator from the control system and controlled by the MBR System control.

3-4.03.08.05. Return Activated Sludge Channel Level Control. The sludge level in the MBR Return Activated Sludge (RAS) channel is managed at a pre-programmed level to minimize the vertical drop over the RAS Weir from the Membrane Basins. The level shall be bracketed. For example, if level climbs too high, the control valve slightly opens. If level is too low, the control valve slightly closes.

The RAS Flow from each basin is monitored and recorded on the plant control system.

Local Manual Mode
Local Manual control of the RAS flow control valve shall be provided through the LOCAL-OFF-REMOTE (L-O-R) selector switch and OPEN-STOP-CLOSE (O-S-C) push buttons mounted near the valve. In the LOCAL position, the valve shall be operated using the OPEN-STOP-CLOSE push buttons.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the L-O-R selector switch near the valve is in the REMOTE position and MANUAL is selected at the HMI, the valve shall be opened and closed from the HMI using manual operator commands.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the L-O-R selector switch near the valve is in the REMOTE position and AUTO is selected at the HMI, the valve shall open to maintain a level in RAS collection channel. The valve shall close after an adjustable time delay (operator selectable at the HMI from 0-120 seconds, initially set at 30 seconds).

Alarms
The PLC shall generate a Valve Fail alarm when the valve position switch indicates that the valve did not reach the commanded position within an adjustable (0-30 sec, initially set at X sec) time delay. The alarm shall be generated only when the valve is in remote mode.

Status Indications
The HMI shall indicate the following valve status:
Valve in Local/Remote.

PLC Powerup
On PLC powerup, control of the valve shall be set to remote manual mode.

Power Failure
Control of the valve shall resume with the control mode established prior to the power failure.

HMI Requirements
The RAS flow control valve shall be depicted on the respective MBR train display similar to the P&ID.

Calculations
None.

3-4.04. REVERSE OSMOSIS SYSTEM – AREA 51.

The advanced treatment system to produce Indirect Potable Reuse (IPR) water is housed in the Reverse-Osmosis/Ultraviolet (RO/UV) Building. The system includes a Reverse-Osmosis (RO) purification system and Ultraviolet Advanced Oxidation Process (UVAOP) disinfection and trace compound oxidation process.

RO removes dissolved and particulate constituents from the feed water, which achieves permeate salinity control, organics removal and additional pathogen log removal credits. RO feed water flows by gravity from the RO feed tanks to the suction side of the RO feed pumps. The RO feed water is pretreated with chemicals to protect the RO membranes against damage from large particles. The water is then pressurized and passed through cartridge filters and two stages of RO membrane elements with a pressure boost before the second stage to achieve flux balance. RO permeate is discharged to the UV AOP system for disinfection/advanced oxidation. RO concentrate is chlorinated as it flows to the ocean outfall pipeline where sodium bisulfite is dosed. The RO system is controlled by a PLC that is integrated into a plant control system that operates the RO feed tanks, RO high pressure feed pumps, concentrate control valves, booster pumps, cartridge filters, CIP makeup and neutralization systems.

The RO System is operated based on RO Feed Tank Level, higher levels indicate higher RO System flow is needed, lower levels indicate lower RO System flow is needed. Each RO train shall be operated with 80-100% of its rated capacity to help ease the flow steps when changing the number of operating pumps. Detailed operating within the RO trains themselves is developed by the ROSS.

Flush procedures are automated. CIP procedures are manually performed by the plant operators.

RO Permeate flows to the UVAOP system by residual pressure.

RO Concentrate flows to the RO Concentrate Disinfection Contactor Pipeline and then to the Outfall Transmission Pipe downstream of the Outfall Pump Station by using residual pressure to drive the flow.

RO System Control Overview

The RO System shall be controlled by the RO System Suppliers standard controls and logic. Control information provided herein is for information only and is a general description of the operating strategy of the system. This description is subject to change to conform to the RO system suppliers' standards and typical operating approach. The RO System Controls will manage the following sub-systems:

- RO High Pressure Feed Pumps;
- Cartridge Filters;
- RO Units;
- CIP Makeup and Neutralization Systems;
- RO Flush System

Associated Equipment

RO Feed Tank # 1 Level	33-RO-LIT-0101
RO Feed Tank # 1 Low-Low Level	33-RO-LSLL-0101
RO Feed Tank # 1 High-High Level	33-RO-LSHH-0101
RO Feed Tank # 2 Level	33-RO-LIT-0201
RO Feed Tank # 2 Low-Low Level	33-RO-LSLL-0201
RO Feed Tank # 2 High-High Level	33-RO-LSHH-0201
RO Feed Conductivity	51-RO-AIT-0001
RO Feed Turbidity	51-RO-AIT-0002
RO Feed Oxidation-Reduction Potential	51-RO-AIT-0003
RO Feed Free Chlorine	51-RO-AIT-0004
RO Feed Monochloramine / Ammonia	51-RO-AIT-0005
RO Feed Ph	51-RO-AIT-0006
RO Feed Pumps Common Header Inlet Flow	51-RO-FIT-0001
RO Pump to Ocean Outfall Tank ISO Valve	51-RO-V-0012

RO System # 1

RO Feed Pump # 1	51-RO-P-0101
RO Cartridge Filter # 1	51-RO-FLC-0101
RO Unit # 1 Feed Valve	51-RO-V-1001
RO Unit # 1 Booster Pump	51-RO-P-1001
RO Unit # 1 Stage 1 Conductivity	51-RO-AIT-1001
RO Unit # 1 Stage 2 Conductivity	51-RO-AIT-1002
RO Unit # 1 Permeate Conductivity	51-RO-AIT-1003
RO Unit # 1 Permeate Flow	51-RO-FIT-1002
RO Unit # 1 Permeate to AOP Valve	51-RO-V-1042
RO Unit # 1 Permeate to Outfall Valve	51-RO-V-1040
RO Unit # 1 Concentrate Flow	51-RO-FIT-1003
RO Unit # 1 Concentrate Conductivity	51-RO-AIT-1004
RO Unit # 1 Stage 2 Permeate Flow	51-RO-FIT-1001
RO Unit # 1 Stage 1 Inlet Pressure	51-RO-PIT-1001
RO Unit # 1 Stage 1 Outlet Permeate Pressure	51-RO-PIT-1002
RO Unit # 1 Stage 1 Outlet Con Pressure	51-RO-PIT-1003
RO Unit # 1 Stage 2 Inlet Pressure	51-RO-PIT-1004
RO Unit # 1 Stage 2 Outlet Con Pressure	51-RO-PIT-1005
RO Unit # 1 Outlet Permeate Pressure	51-RO-PIT-1006
RO Unit # 1 Outlet Con Pressure	51-RO-PIT-1007
RO Unit # 1 Discharge Outlet Con Pressure	51-RO-PIT-1008
RO Unit # 1 Outlet Control valve	51-RO-V-1047
RO Unit # 1 Outlet Control Bypass valve	51-RO-V-1048

RO System # 2

RO Feed Pump # 2	51-RO-P-0201
RO Cartridge Filter # 2	51-RO-FLC-0201
RO Unit # 2 Feed Valve	51-RO-V-2001
RO Unit # 2 Booster Pump	51-RO-P-2001
RO Unit # 2 Stage 1 Conductivity	51-RO-AIT-2001
RO Unit # 2 Stage 2 Conductivity	51-RO-AIT-2002
RO Unit # 2 Permeate Conductivity	51-RO-AIT-2003
RO Unit # 2 Permeate Flow	51-RO-FIT-2002
RO Unit # 2 Permeate to AOP Valve	51-RO-V-2042
RO Unit # 2 Permeate to Outfall Valve	51-RO-V-2040
RO Unit # 2 Concentrate Flow	51-RO-FIT-2003
RO Unit # 2 Concentrate Conductivity	51-RO-AIT-2004
RO Unit # 2 Stage 2 Permeate Flow	51-RO-FIT-2001
RO Unit # 2 Stage 1 Inlet Pressure	51-RO-PIT-2001
RO Unit # 2 Stage 1 Outlet Permeate Pressure	51-RO-PIT-2002
RO Unit # 2 Stage 1 Outlet Con Pressure	51-RO-PIT-2003
RO Unit # 2 Stage 2 Inlet Pressure	51-RO-PIT-2004
RO Unit # 2 Stage 2 Outlet Con Pressure	51-RO-PIT-2005
RO Unit # 2 Outlet Permeate Pressure	51-RO-PIT-2006
RO Unit # 2 Outlet Con Pressure	51-RO-PIT-2007
RO Unit # 2 Discharge Outlet Con Pressure	51-RO-PIT-2008
RO Unit # 2 Outlet Control valve	51-RO-V-2047
RO Unit # 2 Outlet Control Bypass valve	51-RO-V-2048

RO System # 3

RO Feed Pump # 3	51-RO-P-0301
RO Cartridge Filter # 3	51-RO-FLC-0301
RO Unit # 3 Feed Valve	51-RO-V-3001
RO Unit # 3 Booster Pump	51-RO-P-3001
RO Unit # 3 Stage 1 Conductivity	51-RO-AIT-3001
RO Unit # 3 Stage 2 Conductivity	51-RO-AIT-3002
RO Unit # 3 Permeate Conductivity	51-RO-AIT-3003
RO Unit # 3 Permeate Flow	51-RO-FIT-3002
RO Unit # 3 Permeate to AOP Valve	51-RO-V-3042
RO Unit # 3 Permeate to Outfall Valve	51-RO-V-3040
RO Unit # 3 Concentrate Flow	51-RO-FIT-3003
RO Unit # 3 Concentrate Conductivity	51-RO-AIT-3004
RO Unit # 3 Stage 2 Permeate Flow	51-RO-FIT-3001
RO Unit # 3 Stage 1 Inlet Pressure	51-RO-PIT-3001
RO Unit # 3 Stage 1 Outlet Permeate Pressure	51-RO-PIT-3002
RO Unit # 3 Stage 1 Outlet Con Pressure	51-RO-PIT-3003
RO Unit # 3 Stage 2 Inlet Pressure	51-RO-PIT-3004
RO Unit # 3 Stage 2 Outlet Con Pressure	51-RO-PIT-3005
RO Unit # 3 Outlet Permeate Pressure	51-RO-PIT-3006
RO Unit # 3 Outlet Con Pressure	51-RO-PIT-3007
RO Unit # 3 Discharge Outlet Con Pressure	51-RO-PIT-3008
RO Unit # 3 Outlet Control valve	51-RO-V-3047
RO Unit # 3 Outlet Control Bypass valve	51-RO-V-3048

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301, 51-RO-RIO-0401, 80-CTRL-PLC-0001, 51-CTRL-RIO-0001, 31-CTRL-RIO-0001

Associated P&ID(s)
51-I-001, 51-I-002, 51-I-003, 51-I-004, 51-I-005, 51-I-006, 51-I-007, 51-I-008,51-I-009, 51-I-010, 51-I-011, 33-I-001, 34-I-001

3-4.05.01. RO Feed Tanks System.

MBR filtrate is pumped into two FRP tanks piped in parallel. The RO Feed Tanks provide feed water to the RO system and the Plant Recycled Water system. Overflows from the RO feed tanks are discharged to the outfall pump station. The tank levels are measured, displayed locally and transmitted to PLC. The tank has switches that are used to activate the High-High (HH) and Low-Low (LL) Levels. RO feed pumps will convey water from the RO feed tanks through the cartridge filters and through the RO membranes. RO pretreatment chemicals including: sodium hypochlorite, ammonia sulfate, sulfuric acid and antiscalant are added to the RO feed supply line. A locally mounted flow meter measures, displays and transmits to PLC. After chemical has been added a sample pump pulls a portion of the flow from the feed line and discharges it to the RO Feed Analytical Panel where conductivity, turbidity, ORP, free chlorine, pH, ammonia, and monochloramine are measured, displayed and transmitted to the PLC. The Recycled Water Pump Station draws flows directly from RO Feed Tanks. The tanks are operated to maintain a minimum level or higher to provide this water.

The RO Feed Pumps are supplied directly from the RO Feed Tanks by gravity without use of transfer pumps. The level in the RO Feed Tanks shall be used to control the RO System flow.

Any excess water shall be passively overflowed via internal overflow to the Outfall Pump Station for distribution to the Ocean Outfall.

Associated PLC and RIO
80-CTRL-PLC-0001, 31-CTRL-RIO-0001

Associated P&ID(s)
33-I-001

Local Manual Mode
Local Tank level shall be indicated locally via an external level transmitter.

Local Auto Mode
None

Remote Manual Mode
None

Remote Auto Mode
Level in the RO feed Tanks in feet shall be as measured by respective Level Transmitter and shall be monitored at plant control system. A hardwire high-high and low-low level switch shall be provided and wired to directly to the RIO and plant control system for redundant alarming.

Alarms
The HMI shall indicate the following alarms at a minimum:

- RO Feed Tank 1 and 2 High-High Level
- RO Feed Tank 1 and 2 Low-Low Level

Status
The HMI shall indicate the following classifier status:

- RO Feed Tank 1 and 2 Level

PLC Powerup
None

Power Failure
None.

HMI Requirements
The RO feed tank shall be depicted on the display similar to the P&ID. Tanks level shall be indicated accordingly.

Calculations
None.

3-4.04.02. Plant Recycled Water Pump Control.

The Plant recycled water pumps shall be used to convey water from the RO feed tanks to the individual plant units. The recycled water pumps shall be controlled to achieve a flow and pressure set point of main discharge header.

The pump is controlled locally from panel via panel face mounted controls. The pump is PLC interlocked with level in the RO feed tanks to shut down the pump on low level.

Associated PLC and RIO
31-CTRL-RIO-0001

Associated Equipment
31-PRW-P-0101, 31-PRW-P-0201, 31-PRW-P-0301
31-PRW-PSH-0102, 31-PRW-PSH-0202, 31-PRW-PSH-0302
31-PRW-FIT-0001, 31-PRW-PIT-0001

Associated P&ID(s)
34-I-001

Local Manual Mode

Each pump shall be provided with a local mounted On-Off (OO) control station. When the LOS is engaged, the pump shall be prevented from operating. When the START push button is pressed at the local control station, the pump shall run at the set speed.

Each pump motor shall be provided with an RTD assembly. Output from the RTDs shall be routed to the starter, which shall monitor motor temperature and provide an alarm and shutdown the drive if safe operating temperatures are exceeded.

The pumps shall be interlocked to prevent operation when their respective discharge high pressure switch is active. Each pump starter shall generate a FAIL alarm in response to loss of operation.

Local Auto Mode
None

Remote Manual Mode
None

Remote Auto Mode
None

Alarms
The HMI shall indicate the following alarms at a minimum:
- Recycle Water Pump Fail (each pump)
- Recycle Water High Discharge Pressure (each pump)

Status Indications
The HMI shall indicate the following statuses at a minimum:
- Recycle Water Pump Running
- Recycle Water Pump discharge header Flow
- Recycle Water Pump discharge header Pressure

PLC Powerup
On PLC powerup, control of the pumps shall be set to Local manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Recycle water Pumps shall be depicted on the display associated with the RO Feed tank. The display layout shall be similar to the P&ID.

Calculations
None

3-4.04.03. RO Feed Pump Control.

The RO high pressure pumps shall be used to convey water from the RO feed tanks through the cartridge filter to the RO units. The RO high pressure feed pumps (with VFD) shall be controlled to achieve a permeate header flow set point of that RO unit. One feed pump is dedicated to Stage 1 of each RO unit. The RO units shall automatically be brought into and out of service.

Local Manual Mode
Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the pump shall be controlled via the SS control station, with speed control entered locally at the drive.

Each pump shall be provided with a local mounted On-Off (OO) control station. When the LOS is engaged, the pump shall be prevented from operating. When the START push button is pressed at the local control station, the pump shall run at the speed set at the VFD.

Each pump motor shall be provided with an RTD assembly. Output from the RTDs shall be routed to the VFD, which shall monitor motor temperature and provide an alarm and shutdown the drive if safe operating temperatures are exceeded.

The pumps shall be interlocked to prevent operation when their respective Suction low pressure switch and discharge high pressure switch is active.

Each pump VFD shall generate a FAIL alarm in response to loss of operation. The VFD shall accept a discrete “RESET” signal (remote dry contact) which will reset all discrete shutdown alarms, provided the associated alarm condition has cleared. Alarms may also be reset locally at the VFD.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the PCS HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the pump shall be operated from a control station on the PCS HMI with manual input of pump speed.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is in AUTO, operation of the pump shall be controlled automatically by the PLC according to the control sequences in Loop “RO Trains”.

Pump speed shall be controlled to maintain a permeate flow set point for the train. Process flow from the controller shall be the train permeate flow from Loop “RO Train Permeate Flow”.

During train startup and shutdown, the pump shall ramp to and from the set point as described in the control sequences in Loop “RO Trains”.

Alarms
Any alarm condition or other event resulting in loss of operation of a RO Feed Pump shall trigger a shutdown of the respective RO Trains via the TRAIN STOP control sequence in Loop “RO Trains”.

The HMI shall indicate the following alarms at a minimum:
- RO Feed Pump VFD Fail
- RO Feed Pump Low Suction Pressure
- RO Feed Pump High Discharge Pressure

Status Indications
The HMI shall indicate the following statuses at a minimum:
- RO Feed Pump Running
- RO Feed Pump Off
- RO Feed Pump In-Remote
- RO Feed Pump In-Manual (HMI Selection)
- RO Feed Pump In-Auto (HMI Selection)

PLC Powerup
On PLC powerup, control of the pumps shall be set to remote manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The RO Feed Pumps shall be depicted on the display associated with the RO Feed tank and RO train. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.04.04. Cartridge Filters.

RO feed pump will convey water through the dedicated cartridge filter to respective RO train.

Differential pressure is measured across the cartridge filters to provide an indication of the degree of fouling of the filter media as a gauge of when the media requires replacement. A high-high alarm will trigger a shutdown of the RO system (all operating units) to prevent media failure and breakthrough to the RO system.

The PLC calculates the differential pressure and configurable HIGH and HIGH-HIGH differential pressure alarms. On activation of the HIGH-HIGH alarm, shut down the RO system through the SYSTEM STOP control sequence table in Loop “RO Units”.

Local Manual Mode
Differential pressure shall be indicated on the HMI. Transmitters shall be mounted near the filters.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
Calculate configurable HIGH and HIGH-HIGH differential pressure alarms. On activation of the HIGH-HIGH alarm, shutdown the RO system through the SYSTEM STOP control sequence table in Loop “RO Units”.

The HMI shall indicate the following alarms at a minimum:

- RO Cartridge Filter High Differential Pressure (PLC generated)
- RO Cartridge Filter High-High Differential Pressure (PLC generated)

Status Indications
None

PLC Power-Up
Not used.

Power Failure
Not used.

HMI Requirements
The display layout for cartridge filters and associated differential pressure transmitter shall be similar to the P&ID. The differential pressure transmitter shall be shown across the common inlet and outlet pipe manifolds with an indication of measured differential pressure in engineering units of bar.

Calculations
None.

3-4.04.05. RO Units.

Number/Selection of RO Units in Operation

The RO system consists of three RO Units which are independently operated and controlled. RO Units shall be started and stopped based on preset trigger levels in the RO feed tanks. At a given time, 0, 1, 2, or 3 RO units shall be called into service operation. RO units shall be called into and out of service based on the following conditions.

- At HH Tank Level (W ft) all three RO units will operate.
- At Midway Tank Level (X ft) two RO units will operate.
- At Low Tank Level (Y ft) one RO unit will operate

The RO unit with lowest runtime shall be called into service when required.

The RO units shall automatically be brought into and out of service. Concentrate control valves shall be controlled to achieve a set flow rate based on the target recovery of that unit. A booster pump is used to increase second stage feed flow

to balance the flux between first stage and second stage by controlling the permeate flow of the first stage. Pressure is measured on the RO permeate (ROP) and RO concentrate (ROC). Conductivity is measured on the ROP of each stage, displayed locally and transmitted to PLC. The ROP flow rate is measured locally displayed and transmitted to PLC. Pressure is monitored locally, displayed and transmitted to PLC.

ROP pressure is monitored, displayed locally and transmitted to the PLC. In the event of high pressure, a pressure switch generates an alarm at the PLC and the RO system is shut down. A flow meter measures, displays and transmits the RO Unit ROP to PLC. ROP outlet piping three locations. During a normal operation ROP is directed to the UV system for disinfection/advanced oxidation through a flow control valve. Valve controls are set locally. In Local valve position is set using the Open and Close selector switch; in Remote control is passed to the PLC that controls the RO System. Flow not directed to the UV system is a split between the Outfall Pump Station (OPS) and the RO CIP System. Note that RO train ROP to the outfall is combined in a single line to the OPS.

3-4.04.05.01. RO Unit Inlet Water Valves.

The automated feed valves on the suction side of each unit provide for isolation of an off-line unit. The valve is opened during the automated startup sequence for the unit and closed during the automated shutdown sequences.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
51-RO-V-1001, 51-RO-V-2001, 51-RO-V-3001

Associated P&ID(s)
51-I-003, 51-I-004, 51-I-005

Local Manual Mode
Local manual control of the valve is provided at the actuator faceplate when LOR selector switch at control valve is in LOCAL position.

Local Auto Mode
None

Remote Manual Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in MANUAL, the valve shall be controlled by the operator.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in AUTO, position of the valve shall be controlled automatically by the PLC according to the control sequences in Loop “RO Units”.

Alarms
None

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Unit inlet Valve In-Remote

PLC Power-Up
On PLC Power-Up, control of the valve shall be set to remote manual mode.

Power Failure
Control of the valve shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The RO unit inlet water valve(s) shall be depicted on the display associated with the RO Unit. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.04.05.02. RO Unit Flush Feed Valves.

The automated RO unit flush feed valves on the influent side of each RO unit provide for automated flushing of an off-line RO unit. The valve is opened during the automated flush sequence for the unit and closed once the sequence is completed.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
RO-V-0107, RO-V-0207, RO-V-0307

Associated P&ID(s)
51-I-002

Local Manual Mode
Local manual control of the valve is provided at the actuator faceplate when LOR selector switch at control valve is in LOCAL position.

Local Auto Mode
None

Remote Manual Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in MANUAL, the valve shall be controlled by the operator.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in AUTO, the valve shall be controlled automatically by the PLC according to the control sequences in Loop “RO Units”.

Alarms
None

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Unit flushing Valve In-Remote

PLC Power-Up
On PLC Power-Up, control of the valve shall be set to remote manual mode.

Power Failure
Control of the valve shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The RO unit flushing valve(s) shall be depicted on the display associated with the RO Unit. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.04.05.03. RO Unit Booster Pumps.

A booster pump is used to increase second stage feed flow to balance the flux between first stage and second stage by controlling the permeate flow of the first stage. The pumps are equipped with VFDs which allow them to increase pressure overtime as the membranes foul with age while maintaining the same

net production rate from the unit. Pump speed is controlled by the permeate (product) flow rate from the associated unit.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
RO-P-1001
RO-P-2001
RO-P-3001

Associated P&ID(s)
51-I-003, 51-I-004, 51-I-005

Local Manual Mode
Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the pump shall be controlled via the SS control station, with speed control entered locally at the drive.

Each pump motor shall be provided with an RTD assembly. Output from the RTDs shall be routed to the VFD, which shall monitor motor temperature and provide an alarm and shutdown the drive if safe operating temperatures are exceeded.

Each pump VFD shall generate a FAIL alarm in response to loss of operation.

The VFD shall accept a discrete “RESET” signal (remote dry contact) which will reset all discrete shutdown alarms, provided the associated alarm condition has cleared. Alarms may also be reset locally at the VFD.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the pump shall be operated from a control station on the PCS HMI with manual input of pump speed.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector

at the HMI is in AUTO, operation of the pump shall be controlled automatically by the PLC according to the control sequences in Loop “RO Units”.

Pump speed shall be controlled to maintain a permeate flow set point for the unit. Process flow from the controller shall be the unit permeate flow from Loop “RO Unit Permeate Flow”.
During unit startup and shutdown, the pump shall ramp to and from the set point as described in the control sequences in Loop “RO Units”.

Alarms
The HMI shall indicate the following alarms at a minimum:

- RO Unit Booster Pump VFD Fail

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Unit Booster Pump Running
- RO Unit Booster Pump Off
- RO Unit Booster Pump In-Remote
- RO Unit Booster Pump Speed (0-100%)

PLC Power-Up
On PLC Power-Up, control of the pumps shall be set to remote manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

HMI Requirements
The display layout shall be similar to the P&ID.

Calculations
None.

3-4.04.05.04. RO Unit Feed, Differential and Concentrate Pressures.

Feed and differential pressures are monitored across each RO unit to provide an indication of the degree of membrane fouling and help assess when an in-place cleaning of the process membranes is required. The measured values are used in normalized performance equations. The feed pressure is also used to calculate a high-pressure alarm condition and shutdown the unit.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
See P&IDs

Associated P&ID(s)
51-I-003, 51-I-004, 51-I-005

Local Manual Mode
Feed pressure, Stage 1 permeate and concentrate pressure, Stage 2 inlet pressure, and Stage 2 concentrate pressure shall be indicated locally on PIT.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
Calculate configurable HIGH feed pressure and HIGH differential pressure (each stage) alarms for each unit. On activation of the HIGH feed pressure alarm, shutdown the RO unit through the UNIT STOP control sequence table in Loop "RO Units".

The HMI shall indicate the following alarms at a minimum:
- RO Unit Feed Pressure High
- RO Unit Stage 1 Differential Pressure High (PLC Calculated)
- RO Unit Stage 2 Differential Pressure High (PLC Calculated)

Status Indications
The HMI shall indicate the following statuses at a minimum:
- RO Unit Vessel Feed Pressure
- RO Unit Vessel Stage 1 Discharge Pressure
- RO Unit Vessel Stage 2 Inlet Pressure
- RO Unit Concentrate Pressure

PLC Power-Up
None

HMI Requirements
The display layout for the RO units and associated pressure transmitters and calculated differential pressure indicators shall be similar to the P&ID.

Calculations
The controller shall calculate individual stage pressures by subtracting the stage 1 discharge pressure value from the individual stage inlet pressure values. The resulting differential pressure value.

3-4.04.05.05. RO Unit Permeate Pressure.

The pressure in the permeate header on each RO unit is monitored by both an analog transmitter and discrete pressure switch. The analog value is used in calculating net operating or driving pressure associated with the unit and calculating the reverse pressure alarm condition. The discrete switch is used to shut down the unit on detection of a high-pressure condition.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
See P&IDs

Associated P&ID(s)
51-I-006, 51-I-007, 51-I-008

Local Manual Mode
Permeate pressure shall be indicated locally on PITs.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
Receive a discrete HIGH permeate pressure alarm (PSH) for each unit. On activation of the HIGH permeate pressure alarm, shutdown the RO unit through the TERMINATE UNIT control sequence table in Loop “RO Units”.

The HMI shall indicate the following alarms at a minimum:

- RO Unit Permeate Pressure High

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Unit Permeate Pressure

PLC Power-Up
None.

Power Failure
None.

HMI Requirements
The display layout for the RO units and associated permeate pressure transmitters and switches shall be similar to the P&ID.

Calculations
None.

3-4.04.05.06. RO Unit Permeate Flow.

Permeate flow from each RO unit is monitored to provide control of the associated feed pump speed according to a “permeate flow set point” for the unit. The flow signal is also used to calculate a high flow alarm and shutdown the unit. A totalizer for permeate flow from each individual RO unit is provided. The totalizer value is displayed in engineering units of liters.

The flow from FITs shall be totalized, and this totalized flow signal shall be displayed on the HMI. This totalized flow signal shall also be used for chemical dosing the inlet to the Product Water Storage Tank.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
See PIDs

Associated P&ID(s)
51-I-006, 51-I-007, 51-I-008

Local Manual Mode
Permeate flow shall be indicated locally on FITs.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

- RO Unit Permeate High Flow (PLC Calculated)

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Unit Permeate Flow
- RO Permeate Totalized Flow

PLC Power-Up
None.

Power Failure
None.

HMI Requirements
The display layout for the RO unit permeate flow shall be similar to the P&ID. The flow meter shall be shown on the main permeate header from the RO unit(s) with an indication of measured flow in engineering units of cubic meters/hour. Display values from the totalizer, including current gross total as well as daily, weekly and monthly values.

Calculations
Provide a totalizer for permeate flow from each individual RO unit. The totalizer shall readout in engineering units of liters.

3-4.04.05.07. RO Unit Permeate Isolation Valves.

Each unit is equipped with a motorized valve on the permeate header to provide automated isolation on unit shutdown. The valve prevents the accumulation of backpressure on an offline unit. The valve is opened during the automated startup sequence for the unit and closed during the automated shutdown sequences.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
See P&IDs

Associated P&ID(s)
51-I-006, 51-I-007, 51-I-008

Local Manual Mode
Local manual control of the valve is provided at the actuator faceplate when LOR selector switch at control valve is in LOCAL position.

Local Auto Mode
None

Remote Manual Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in MANUAL, the valve shall be controlled by the operator.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in AUTO, the valve shall be controlled automatically by the PLC according to the control sequences in Loop “RO Units”.

Alarms
None

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Unit permeate Valve In-Remote

PLC Power-Up
On PLC Power-Up, control of the valve shall be set to remote manual mode.

Equipment Power Failure
Control of the valve shall resume with the control mode established prior to the power failure.

HMI Requirements
The RO unit permeate valve(s) shall be depicted on the display associated with the RO Unit. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.04.05.08. RO Unit Concentrate Control Valves.

The concentrate control valve on each RO unit controls the flow of reject or concentrate from the unit, and in effect the recovery of water from the unit (amount of permeate produced per unit of feed water). The valves are equipped with modulating actuators whose position is controlled to maintain a concentrate flow set point. The flow set point is calculated based on inputs for the unit permeate flow set point and recovery set point. The valve is ramped from an open position at startup to the control set point; and then ramped back open during shutdown.

Associated PLC and RIO
51-RO-PLC-0001, 51-RO-RIO-0101, 51-RO-RIO-0201, 51-RO-RIO-0301

Associated Equipment
See P&IDs

Associated P&ID(s)
51-I-006, 51-I-007, 51-I-008

Local Manual Mode
Local manual control of the valve is provided at the actuator faceplate when LOR selector switch at control valve is in LOCAL position.

Local Auto Mode
None

Remote Manual Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in MANUAL, the valve shall be controlled by the operator.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in AUTO, the valve shall be controlled automatically by the PLC according to the control sequences in Loop “RO Units”.

Valve position shall be controlled to maintain a calculated concentrate flow set point for the unit. Process flow from the controller shall be the unit concentrate flow from Loop “RO Unit Concentrate Flow”.

During unit startup and shutdown, the valve shall ramp to and from the set point as described in the control sequences in Loop “RO Units”.

Alarms
None

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Unit Concentrate Valve In-Remote

PLC Power-Up
On PLC Power-Up, control of the valve shall be set to remote manual mode.

Equipment Power Failure
Control of the valve shall resume with the control mode established prior to the power failure.

HMI Requirements
The RO unit concentrate valve(s) shall be depicted on the display associated with the RO Unit. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.04.05.09. RO Units.

The RO units provide demineralization of the inlet feed water to meet stringent quality goals for the facility product water associated with alkalinity, total hardness, and silica. Operation of the RO units require the integrated operation of sub-components of the system (e.g., pumps, valves, instruments) and sub-systems (e.g., transfer pumps, chemical feed systems). Overall operation of the RO units and system as a whole is based on automated control sequences governing startup, operation and shutdown.

Associated PLC and RIOs
80-CTRL-PLC-0001, 51-RO-LCP-0001

Associated Equipment
RO System
See P&ID 51-I-003,004,005

1st Pass RO Units
Unit 1
Unit 2
Unit 3

Associated P&ID(s)
51-I-003, 51-I-004, 51-I-005

Local Manual Mode

None.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
Defined sequences are included for the following:

- First Unit Start
- Second Unit Start
- Unit Stop
- Terminate Unit (emergency stop)
- System Stop (shutdown all operating units)
- Terminate System
- Unit Flush

3-4.04.05. RO Flushing System.

A portion of the ROP is directed to the RO Flush Tank for use in flushing the membranes. An automatic valve is located on the flushing feed to admit permeate when the tank is low. Valve open and close can be set at the PLC.

The tank level is measured, displayed locally and transmitted to PLC. The tank has switches that are used to activate the High-High and Low-Low Levels.

The tank supplies the RO flush pumps which discharge the ROP through the cartridge filer and then through the RO system. Pump controls are set locally. In the ON position the pump runs continuously; in the OFF position the pump does not run. Pump duty selection (duty, standby, or out of service) and pump start and stop levels are set from the configuration screen. In the event the Duty pump fails the Standby pump runs. When a pump is selected as out of service the pump is taken out of the control loop. The Duty pump starts at a preset low tank level and stops when the high level set point is reached. Discharge pressure is shown locally on the pump discharge. Pressure is monitored on the cartridge filter supply and is displayed locally and transmitted to PLC.

3-4.04.06.01. RO Flush Pump.

The RO Flush Pumps draws from the RO Flushing Tank and provides a flush supply to the RO units. The duty pump is called to operate automatically when a RO unit is flushed and shall maintain a RO flush header flow.

Associated PLC and RIO
51-RO-PLC-0001

Associated Equipment
51-FIT-0002
51-RO-P-0102
51-RO-P-0202

Associated P&ID(s)
51-I-011

Local Manual Mode
Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the pump shall be controlled via the SS control station, with speed control entered locally at the drive.

Each pump shall be provided with a local mounted Start-Lockout-Stop (SLOS) control station. When the LOS is engaged, the pump shall be prevented from operating. When the START push button is pressed at the local control station, the pump shall run at the speed set at the VFD.

Each pump motor shall be provided with an RTD assembly. Output from the RTDs shall be routed to the VFD, which shall monitor motor temperature and provide an alarm and shutdown the drive if safe operating temperatures are exceeded.

The pumps shall be interlocked to prevent operation when their associated discrete LWCO is active from the RO Flush Tank (LSL-0001).

Each pump VFD shall generate a FAIL alarm in response to loss of operation.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the

operation of the pump shall be operated from a control station on the HMI with manual input of pump speed.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the HMI is in AUTO, operation of the pump shall be controlled automatically by the PLC according to the control sequences in Loop “RO Units”.

Pump speed shall be controlled to maintain a RO flush pump discharge header flow set point.

During unit startup and shutdown, the pump shall ramp to and from the set point as described in the control sequences in Loop “RO Units”.

Alarms
Any alarm condition or other event resulting in loss of operation of a RO Feed Pump shall trigger a shutdown of the respective RO Units via the UNIT STOP control sequence in Loop “RO Units”.

The HMI shall indicate the following alarms at a minimum:

- RO Flush Pump VFD Fail

The PLC shall calculate a change-of-state alarm related to loss of run feedback from an operating pump.

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Flush Pump Running
- RO Flush Pump In-Remote
- RO Flush Pump Speed (0-100%)

PLC Power-Up
On PLC Power-Up, control of the pumps shall be set to remote manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

HMI Requirements
The RO Flush Pump shall be depicted on the display associated with the Product Water Storage Tank. The display layout shall be similar to the P&ID.

Calculations
None

3-4.04.06.02. RO Flushing Tank Level.

The RO Membrane Flush Tank stores RO permeate water and provides a reservoir for the RO Flush Pump Station. Level is monitored to provide an indication of storage as well as activate alarms.

Associated PLC and RIO
51-RO-PLC-0001

Associated Equipment
51-RO-T-0001, 51-RO-LIT-0001, 51-RO-LSL-0001, 51-RO-LSH-0001, 51-RO-V-0013

Associated P&ID(s)
51-I-011

Local Manual Mode
Tank level shall be indicated locally via an external level sight gauge.

Local manual control of the valve is provided at the actuator faceplate when LOR selector switch at control valve is in LOCAL position.

Local Auto Mode
None

Remote Manual Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in MANUAL, the valve shall be controlled by the operator to maintain level in RO Flush tank.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in AUTO, the valve shall be controlled automatically by the PLC according to the control sequences in Loop “RO Units”.
Valve shall be controlled to maintain a level in RO flush tank.

Alarms
The HMI shall indicate the following alarms at a minimum:

- RO Membrane Flush Tank High-High Alarm Level
- RO Membrane Flush Tank Low- Low Alarm Level

Status Indications

- RO Flush Tank Inlet Valve In Remote

PLC Power-Up
Not used.

Power Failure
Not used.

HMI Requirements
The display layout for the RO Membrane Flush Tank shall be similar to the P&ID as part of the RO Flush Pumping Station.

Calculations
None

3-4.04.07. RO CIP Makeup Tank.

RO CIP solution is formulated in the RO CIP Makeup Tank. High pH and low pH cleaning solutions are prepared using sodium hydroxide and citric acid, respectively. Make up water is provided from the RO permeate header. The ROP line includes a flow meter and flow control valve to measure the makeup water volume added to the tank.

The CIP Pumps draw from either of the CIP Makeup Tanks and discharge flow through CIP cartridge filters to the RO membrane elements. The majority of the CIP solution is recycled through the ROC piping back to the CIP Make up tank. A small portion of the CIP solution passes through the membranes and is returned to the CIP Makeup Tank.

3-4.04.07.01. RO CIP Tank Level.

The tank includes a site gauge to determine CIP level, a LL switch and a high HL. On low level an alarm is generated to notify the Operator. The HL switch signals that an overflow event is imminent.

Associated PLC and RIO
80-CTRL-PLC-0001, 51-RO-PLC-0001

Associated Equipment
51-CIP-T-0101, 51-CIP-LIT-0101

Associated P&ID(s)
51-I-009

Local Manual Mode
Monitor tank levels locally by site glass and remotely via 51-LIT-0101 transmit signal to the PLC.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

- RO CIP Tank Low Alarm Level
- RO CIP Tank High Alarm Level

Status Indications

The HMI shall indicate the following statuses at a minimum:

- RO CIP tank Level (0-xx.x m)

PLC Power-Up
Not used.

Power Failure
Not used.

HMI Requirements
Provide a control screen on the HMI for the RO cleaning system. Include a schematic for the cleaning tank and display tank level—both numerically and graphically through an active display tied to level in the tank.

Calculations
Not used.

3-4.04.07.02. RO CIP Pump.

The RO CIP pump recirculates prepared cleaning solutions either for mixing or to and from the RO unit being cleaned. The pump is controlled locally from panel

TBD via panel face mounted controls. The pump is interlocked with level in the RO CIP Tank to shut down the pump on low level.

Associated PLC and RIO
51-RO-PLC-0001

Associated Equipment
51-CIP -P-0011, 51-CIP-P-0012

Associated P&ID(s)
51-I-010

Local Manual Mode
Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the pump shall be controlled via the SS control station, with speed control entered locally at the drive.

Provide manual pump control from RO CIP Instrument Panel (TBD), via start-stop pushbuttons or a switch. A potentiometer shall be provided at the RO CIP Instrument Panel (TBD) to manually adjust the pump speed. The run control at the panel shall interface with the pump run control circuit in the VFD to run the pump. The VFD shall provide a run indication signal back to the RO CIP Instrument Panel (TBD), along with a VFD fail alarm signal. Both signals shall be indicated via lamps on the face of the RO CIP Instrument Panel (TBD).

The pumps shall be interlocked to prevent operation when their associated discrete LWCO alarm is active from the CIP Makeup Water Tank LWCO switch.

Each pump VFD shall generate a FAIL alarm in response to loss of operation.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the pump shall be operated from a control station on the HMI with manual input of pump speed.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

- RO CIP Pump VFD Fail

The PLC shall calculate a change-of-state alarm related to loss of run feedback from an operating pump.

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO CIP Pump Running
- RO CIP Pump In-Remote
- RO CIP Pump Speed (0-100%)

PLC Power-Up
On PLC Power-Up, control of the pumps shall be set to remote manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

HMI Requirements
None.

Calculations
Not used.

3-4.04.08. RO Neutralization Tank.

The Neutralization Tank is used to neutralize spent CIP cleaning solutions prior to discharge. The spent cleaning solution returns to the Neutralization Tank through the RO CIP return line. Depending on the pH of the spent cleaning solution citric acid or sodium hydroxide is added to the neutralization tank and mixed until the target pH is achieved. Mixer controls are located at the MCC and include a control selectors switch (Local-Off-Remote [LOR]) and reset pushbutton. In the Local position the pump runs continuously when the local control switch is in Start and stops when the switch is in Stop. Placing the local control switch in LO locks out the mixer. The neutralization tank includes a site gauge to determine, a low-level switch and a high-level switch. On low level an alarm is generated to notify the Operator. The high-level switch signals that an overflow event is imminent. The tank is equipped with overflow piping and drain valve which is used to direct neutralized cleaning solution to the RO CIP Containment Area. A pH analyzer and level sensor are located on the overflow line. Both are displayed locally and transmitted to PLC.

Associated PLC and RIO
80-CTRL-PLC-0001, 51-RO-PLC-0001

Associated Equipment
51-CIP-T-0201, 51-CIP-LIT-0201

Associated P&ID(s)
51-I-009

Local Manual Mode
Monitor tank levels locally by site glass and remotely via 51CIP-LIT-0201 transmit signal to the PLC.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

- RO Neutralization Tank Low-Low Alarm Level
- RO Neutralization Tank High Alarm Level

Status Indications
The HMI shall indicate the following statuses at a minimum:

- RO Neutralization Tank Level (0-xx.x ft) xx.x provided by RO System Supplier.

PLC Power-Up
Not used.

Power Failure
Not used.

HMI Requirements
Provide a control screen on the HMI for the RO cleaning system. Include a schematic for the cleaning tank and display tank level—both numerically and graphically through an active display tied to level in the tank.

Calculations
Not used.

3-4.05. ULTRAVIOLET ADVANCED OXIDATION PROCESS – AREA 52.
The Ultraviolet Advanced Oxidation Process (UVAOP) provides two mechanisms for treating contaminants – disinfection via direct photolysis and oxidation via free hydroxyl radical formation. The UVAOP system is designed to achieve target pathogen and 1,4 dioxane log reduction value (LRV) based on DDW requirements for IPR via groundwater recharge by direct injection. The UV system receives permeate from the RO units and discharges product water to the Product Water Storage Tank. The UV system is comprised of one treatment train (Duty) with the train consisting of single UV reactor. Sulfuric acid and sodium hypochlorite provide pretreatment to the UV reactors and are dosed to the influent header. Disinfected flow that does not meet specifications may be bypassed to the Outfall Balancing Tank.

The UV system is an enclosed system that functions to provide specific wavelengths of electromagnetic radiation to inactivate microorganisms by damaging life sustaining biochemicals (e.g. DNA, RNA, proteins) and rendering them unable to replicate. The UV power shall be adjusted automatically based on changes in influent flow, temperature, pH, UVT, oxidant dose, and lamp age to achieve the desired target treatment requirements. UV reactor is provided with a chemically free automatic wiping system which functions to avoid formation of organic and inorganic deposits on the UV lamps. Removal of 1,4 dioxane is provided by advanced oxidation by using sodium hypochlorite upstream of the UV process to create free hydroxyl radicals. The efficiency of free hydroxyl formation using sodium hypochlorite is significantly impacted by pH therefore sulfuric acid is dosed upstream of sodium hypochlorite to achieve desired pH (e.g. 5-5.5).

The UVAOP System receives RO Permeate by residual pressure from the RO System. Sodium Hypochlorite is injected upstream of the UVAOP System. The UVAOP System is controlled by a vendor control system to deliver the required dose. Out of spec water is bypassed to the Outfall Pump Station.

Effluent from the UVAOP System flows via residual pressure to the Calcite Contactor System.

Under normal operating conditions the UV AOP system operates in Remote Auto through the PCS. In general, the UV AOP system shall be controlled using a monitoring algorithm for the calculation of 1,4-Dioxane LRV as a function of several inputs such as flow rate, UV transmittance (UVT), UV intensity, lamp status, free chlorine concentration and pH. The specific monitoring algorithm shall be developed by the equipment supplier and shall include computational fluid dynamic (CFD) modeling to validate the accuracy of the algorithm for the calculation of 1,4 Dioxane reduction. A description of the user operator interface is provided below.

The UV AOP will continuously monitor the LRV achieved for the target contaminant (i.e. 1,4 Dioxane). The UV AOP system will normally be operated to provide a target LRV that is maintained above the minimum LRV required for regulatory compliance. The target LRV provides an operating buffer above the required LRV so that changes in the process variables (i.e. flow, UVT, etc.) that cause minor fluctuations in the target contaminant LRV provided by the UV AOP system does not result in off-specification water production. The UV AOP system shall allow for operator selection of both the required and target LRV for the target contaminant. The UV AOP system shall continuously monitor the LRV of the target contaminant and alarm if the LRV falls below either the target LRV set point (low priority alarm) or the required LRV set point (high priority off-specification alarm). Monitoring of pathogen LRVs is not anticipated to be required as the UV dose required for AOP far exceeds that for disinfection; however, this shall be vetted with DDW during the final design.

Associated PLC and RIO
52-UV-PLC-0001

Associated Equipment
52-UV-UVU-0101

Associated P&ID(s)
52-I-001

Local Manual Mode
None

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

Status Indications
The HMI shall indicate the following statuses at a minimum:

- UV Unit inlet Free Chlorine
- UV Unit inlet UVT
- UV Unit inlet pH
- UV Unit outlet pH
- UV unit discharge flow

PLC Power-Up
Not used.

Power Failure
Not used.

HMI Requirements
Provide a control screen on the HMI for the UV AOP system

Calculations
Not used.

3-4.06. EFFLUENT AREA – AREA 60.

Effluent from the UVAOP System flows by residual head through a Calcite Contactor and into the IPR Product Water Storage Tank. From there it is pumped to the IPR Injection Wellfield (by others) by the IPR Pump Station.

The Effluent Area also includes the Ocean Outfall System which includes the Ocean Outfall Balancing Tank, Outfall Pump Station, Outfall Disinfection Pipeline Contactor, and RO Concentrate Disinfection Pipeline Contactor. Effluent from the two contactors is combined and dechlorinated at the Dechlorination Station before leaving the site in the Ocean Outfall pipeline.

3-4.06.01. Calcite Remineralization System.

Product water from the UVAOP system undergoes post treatment stabilization (consisting of calcite remineralization contactor and sodium hydroxide addition) to reduce corrosivity and increase pH. Sodium hypochlorite is then added upstream of the product water storage tank to achieve a free chlorine residual for additional disinfection. The product water storage tank provides operational storage for the AOP product water. The IPR pump station conveys the purified water to injection wells (by others) via the AWPF distribution pipeline. The AWPF distribution pipeline provides chlorine contact time to achieve additional disinfection.

UV effluent shall pass through a vessel containing calcite which will dissolve into the water and add hardness, alkalinity and increase the pH to protect downstream equipment from corrosion. The system is designed to permit full plant flow through the online (duty) vessel. A second vessel is used in a standby role when the duty vessel requires while cleaning. UV effluent flowing through the online vessel dissolves some of the media to a neutral pH (about 7.0) and

delivers stabilized water to the Product Water Tank (PWT). The differential pressure is measured across the media bed in each vessel. At a preset high differential pressure, a switch is energized which generates an alarm to PCS.

The Calcite Contactor System receives Flow to the UVAOP System via residual pressure. The flow moves through calcite media to absorb minerals and then flows via residual pressure to the IPR Product Water Storage Tank. The Calcite Contractor is a passive system not requiring any online process control.

Loading of new media and backwashing that media is manually performed by the operators. The Calcite Contractor is equipped with backwash / flush pump and Backwash Waste Holding Tank to allow for slow discharge of backwash waste to the plant sewer system to not cause a process upset.

Associated PLC and RIO
51-CTRL-RIO-0001

Associated Equipment
61-CAL-FLT-0101, 61-CAL-FLT-0201, 61-CAL-P-0001, 61-CAL-VFD-0001

Associated P&ID(s)
61-I-001

Local Manual Mode
Filters shall be flushed base on the differential pressure across individual filters. Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the pump shall be controlled via the local control station, with speed control entered locally at the drive. Pump VFD shall generate a FAIL alarm in response to loss of operation. One vessel sized to allow entire flow to pass through a single vessel so that the other can be taken offline for service or media loading.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC base on eth differential filter high signal, with manual initiation of operation at the HMI. Provide a control station at the HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the HMI is MANUAL, the operation of the pump shall be operated from a control station on the PCS HMI with manual input of pump speed.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Flush Pump VFD Fail
- Flush Pump high temperature
- Flush Pump overload
- Calcite filter 1 differential pressure
- Calcite filter 2 differential pressure

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Calcite filter inlet pH
- Calcite filter outlet pH
- Flush Pump Running
- Flush Pump In-Remote
- Flush Pump Speed (0-100%)

PLC Power-Up
On PLC Power-Up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
None.

Calculations
Not used.

3-4.06.02. Calcite Contactor Backwash Waste Holding Tank

The Calcite Contactor Backwash Waste Holding Tank level is measured and displayed locally and the level transmitted to the plant control system. In the event of a high tank level an overflow directs the water to the ground. A motorized tank drain is used to drain the tank contents to the sewer or storm drain. Controls are mounted on the valve actuator. A flow meter is located on the drain line and measures, displays locally and transmits the flowrate to plant control system.

Associated PLC and RIO
80-CTRL-PLC-0001, 51-CTRL-RIO-0001

Associated Equipment
61-CAL-T-0001, 61-CAL-LIT-0001, 61-CAL-FIT-0001, 61-CAL-V-0001

Associated P&ID(s)
61-I-001

Local Manual Mode
Local manual control of the valve is provided at the actuator faceplate when LOR selector switch at control valve is in LOCAL position.

Local Auto Mode
None

Remote Manual Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in MANUAL, the valve shall be controlled by the operator.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the control valve is in the REMOTE position and the MA selector at the HMI is in AUTO, the valve shall be controlled automatically by the PLC to maintain the level in tank.

Alarms
None

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Drain Valve In-Remote, Open, Closed
- BH Tank Level
- BH Tank Discharge Flow

PLC Power-Up
On PLC Power-Up, control of the valve shall be set to remote manual mode.

Equipment Power Failure
Control of the valve shall resume with the control mode established prior to the power failure.

HMI Requirements
BHT shall be depicted on the display associated with the Calcite Remineralization system. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.06.03. Product Water Storage Tank

The Product Water Storage Tank stores the UV Effluent Prior to pumping the treated water to the groundwater well injection site. It has level sensors and alarms on high and low levels. There are no other controls on the Product Water Storage Tank.

The IPR Product Water Storage Tank stores IPR Product water for distribution to the IPR Injection Wellfield (by others) via the IPR Product Water Pump Station. The IPR Product Water Storage Tank also stores IPR Product water to supply backwash water to the Calcite Contactor in order to backwash and clean a new delivery of calcite.

Associated PLC and RIO
80-CTRL-PLC-0001, 51-CTRL-RIO-0001

Associated Equipment
62-TW-T-0001

Associated P&ID(s)
62-I-001

Local Manual Mode
Level shall be monitored locally via Level slight gauge and Level transmitter.

Local Auto Mode
None

Remote Manual Mode
Level shall be monitored remotely via level transmitters, high-high and low-low level switches.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Product Water tank level Low-Low
- Product Water tank level High-High

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Product Water Tank level

PLC Power-Up
None.

Equipment Power Failure
None.

HMI Requirements
Product Water Tank shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.06.04. Product Water Pump Station.

The IPR pumps operate based on the Product Water Storage Tank level. The pumps send the Product Water to the groundwater well injection site. The pumps are operated directly by plant PLC system. The Operators select lead, lag1, and lag2 pumps through the HMI. Pumps can also be taken Out-Of-Service. The PLC starts or stops pumps and adjusts speed uniformly to maintain either operator input flow set point or pressure set point. The pumps can be manually operated in the PLC to start/stop and set operating speed if needed. Normally the system operates in Remote Auto with all pumps in service and each pump selected for a duty role (lead, lag and lag-lag).

Associated PLC and RIO
80-CTRL-PLC-0001, 51-CTRL-RIO-0001

Associated Equipment
63-TW-P-0101, 63-TW-P-0201, 63-TW-P-0301
63-TW-VFD-0101, 63-TW-VFD-0201, 63-TW-VFD-0301
63-TW-PIT-0001, 63-TW-LIT-0001

Associated P&ID(s)
63-I-001

Local Manual Mode
Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the

pump shall be controlled via the SS control station, with speed control entered locally at the drive.

Each pump shall be provided with a local mounted On-Off (OO) control station. When the LOS is engaged, the pump shall be prevented from operating. When the START push button is pressed at the local control station, the pump shall run at the speed set at the VFD.

Each pump motor shall be provided with an RTD assembly. Output from the RTDs shall be routed to the VFD, which shall monitor motor temperature and provide an alarm and shutdown the drive if safe operating temperatures are exceeded.

The pumps shall be interlocked to prevent operation when their respective discharge high pressure switch and low-low level in product water tank is active.

Each pump VFD shall generate a FAIL alarm in response to loss of operation.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the PCS Operator HMI. Provide a control station at the PCS Operator HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS Operator HMI is MANUAL, the operation of the pump shall be operated from a control station on the PCS Operator HMI with manual input of pump speed.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is in AUTO, operation of the pump shall be controlled automatically by the PLC.

Pump duty selection (lead, lag, and lag-lag pumps, or set a put to be out of service) is set from the configuration screen. In the event the lead pump fails the lag pump is promoted to the lead pump role; should the lag pump fail the lag-lag pump is promoted to the lag pump role. When a pump is selected as out of service, the pump is taken out of the control loop. The pump starts, stops and speed is adjusted to maintain the input flow set point or pressure set point. A pressure switch located on the pump discharge generates an alarm to PCS and shuts down a pump. The product water pump discharge to a common manifold. Flow, discharge pressure and pH are measured, displayed locally and transmitted to PCS.

Alarms
The HMI shall indicate the following alarms at a minimum:

- IPR Pump VFD Fail
- IPR Pump High Discharge Pressure

Status Indications
The HMI shall indicate the following statuses at a minimum:

- IPR Pump In-Remote
- IPR Pump Running
- IPR Pump Fail

PLC Powerup
On PLC powerup, control of the pumps shall be set to remote manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The IPR Pumps shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.06.05. Outfall Balancing Tanks and Pumps.

The outfall balancing tank provides operational storage for MBR effluent, SAFE System effluent, or off-spec IPR water. The outfall (effluent) pump station conveys the flows to the ocean outfall from this tank.

The Outfall Balancing Tank receives, blends, and equalizes flows for the Outfall Pump Station. This system receives:

- Membrane Filtrate (MFF) from the MBR system
- Filtered Outfall Water (FOW) from the SAFE System
- RO Feed (ROF) and RO train permeate (ROP) off-spec water from the RO System
- UV Effluent (UVE) off-spec water from the UVAOP System

This system does not receive concentrate from the RO System. The residual pressure from that system is used to route that flow to the Ocean Outfall Transmission Main downstream of the Outfall Pump Station.

The Outfall Pump Station is operated based on various levels in the Outfall Pump Station, with higher level indicating more pumping is required and lower level indicating less pumping is required.

Ocean Outfall water is disinfected in an onsite pipeline contactor and then dechlorinated at the Dechlorination Station before flowing via the Outfall Transmission Main (by others) to the Ocean Outfall (by others). Sodium hypochlorite is dosed in the Ocean Outfall Pump Station discharge upstream of the outfall disinfection pipeline contactor. The Ocean Disinfection Pipeline Contactor is configured to provide plug-flow contact volume. The pipeline contactor is sloped downward continuously in the direction of flow toward a blow-off at the Dechlorination Station. Residual pressure in the system can be used at that location to blow-down any settled fines or precipitants to the plant sewer for maintenance. From there, the flow is blended with flow from the RO Concentrate Disinfection Contactor Pipeline and dechlorinated at the Dechlorination Station before leaving the site via the Outfall Transmission Pipeline.

Any solids accumulated in the contactor are manually blown down to the plant sewer by the operators. This is expected to be rarely needed.

The concentrate is dosed with sodium hypochlorite at the entry of the pipeline contactor to disinfect the concentrate and sodium bisulfite at Dechlorination Station to reduce the chlorine residual. The pipeline contactor is sloped downward continuously in the direction of flow toward a blow-off at the Dechlorination Station. Residual pressure in the system can be used at that location to blow-down any settled fines or precipitants to the plant sewer.

Associated PLC and RIO
80-CTRL-PLC-0001, 51-CTRL-RIO-0001

Associated Equipment
64-TW-P-0101, 64-TW-P-0201, 64-TW-P-0301, 64-TW-P-0401
64-TW-VFD-0101, 64-TW-VFD-0201, 64-TW-VFD-0301, 64-TW-VFD-0401
64-TW-T-0001, 64-TW-LIT-0001, 64-TW-LSH-0001, 64-TW-LSL-0001

Associated P&ID(s)
64-I-001

Local Manual Mode
Outfall Balancing tank level shall be monitored locally via Level slight gauge and Level transmitter.

Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the pump shall be controlled via the SS control station, with speed control entered locally at the drive.

Each pump shall be provided with a local mounted On-Off (OO) control station. When the LOS is engaged, the pump shall be prevented from operating. When the START push button is pressed at the local control station, the pump shall run at the speed set at the VFD.

Each pump VFD shall generate a FAIL alarm in response to loss of operation.

Local Auto Mode
None

Remote Manual Mode
Outfall Balancing tank level shall be monitored remotely via level transmitter, high and Low level switches.

Remote manual control for pumps shall be provided through the PLC, with manual initiation of operation at the PCS HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the pump shall be operated from a control station on the PCS HMI with manual input of pump speed. Pump duty selection (lead, lag, and lag-lag pumps, or set a put to be out of service) shall be set manually to maintain level in the Outfall balancing Tank.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is in AUTO, operation of the pump shall be controlled automatically by the PLC.

Pump duty selection (lead, lag, and lag-lag pumps, or set a put to be out of service) is set from the configuration screen. In the event the lead pump fails the lag pump is promoted to the lead pump role; should the lag pump fail the lag-lag pump is promoted to the lag pump role. When a pump is selected as out of service, the pump is taken out of the control loop. The pump start, stop and adjust speed to maintain the input flow set point or pressure set point. A pressure switch located on the pump discharge generates an alarm to PCS and shuts down a pump. The outfall pump discharge to a common manifold. Flow, discharge flow and Residual Chlorine is measured, displayed locally and transmitted to PCS.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Outfall Balancing tank level High
- Outfall Balancing tank level Low
- Outfall Pump VFD Fail

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Outfall Balancing tank level
- Outfall Pump In-Remote
- Outfall Pump Running
- Outfall Pump Station discharge Flow
- Outfall Pump Station discharge Pressure

PLC Powerup
On PLC powerup, control of the pumps shall be set to remote manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Outfall balancing Pumps and tank shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.07. RESIDIALS AREA - AREA 70.

3-4.07.01. Sludge Holding Tanks.

The sludge holding tanks receive, store, and aerate activated sludge wasted from the BNR-MBR process. The holding tanks consist of a two-cell design, with each zone designed to operate independently. Each zone shall include a mixer to mix the WAS sludge and coarse bubble diffusers to aerate it. The aeration will cycle to avoid excessively low pH values. The tanks are not designed to digest the sludge to meet state standards. It is expected that normally only one zone shall be in use to minimize sludge age for optimization of dewatering system performance. The facility is designed to operate the belt press two days a week for 8 hours per day.

Sludge Holding tank will receive sludge from MBR process and the scum from the BNR process, tanks will store and aerate activated sludge to minimize sludge age for optimization of dewatering system performance.

The Sludge Holding Tanks receive WAS sludge from the WAS and Scum Pumps. The operators manually configure valving to select which tank to deliver

sludge to. The operators also manually configure valving to select which tank the Sludge Pumps will draw from.

The tanks are equipped with mixers to keep solids suspended at lower tank levels and coarse bubble diffusers to aerate and mix the tank at levels above that. Operators manually select which mode to operate in from the PLC based on tank level and operational needs.

The sludge holding tank mixers can be operated in Manual or Remote modes as described below. The mixers shall stop in any mode upon moisture detection, motor winding high temperature or a pre-programmed low-sludge level. The mixer status is displayed at the PCS.

Associated PLC and RIO
72-CTRL-RIO-0001, 80-CTRL-PLC-0001

Associated Equipment
71-WAS-T-0001, 71-WAS-T-0002, 71-WAS-MXR-0101, 71-WAS-MXR-0201
71-WAS-LIT-0101, 71-WAS-LIT-0201, 71-WAS-AIT-0101, 71-WAS-AIT-0201

Associated P&ID(s)
71-I-001

Local Manual Mode
Sludge Holding tank level shall be monitored locally via Radar type Level transmitter.

Local manual control of the mixers shall be provided through the mixer control box. When the LOR switch is in the LOCAL position, the mixer shall be controlled via the local control station,

Local Auto Mode
None

Remote Manual Mode
Remote manual control for mixers shall be provided through the PLC, with manual initiation of operation at the PCS HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the LCP is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the mixer shall be operated from a control station on the PCS HMI with manual input.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the LCP is in the REMOTE position and the MA selector at the PCS HMI is in AUTO, operation of the mixer shall be controlled automatically by the PLC based on Intermittent Operation using operator adjustable set-points for

the interval between mixer operation and duration of mixer operation; or as a continuous Operation.

Sludge holding DO tank shall be monitored by the PCS.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Sludge Holding Tank Mixer Fail
- Sludge Holding Tank DO Analyzer Fail

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Sludge Holding Tank Level
- Sludge Holding Tank Mixer In-Remote
- Sludge Holding Tank Mixer Running

PLC Powerup
On PLC powerup, control of the mixers shall be set to remote manual mode.

Power Failure
Control of the mixers shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Sludge holding tank and Mixer shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.07.02. Sludge Holding Tank Blowers.

The tanks are equipped with mixers to keep solids suspended at lower tank levels and coarse bubble diffusers to aerate and mix the tank at levels above that. Dedicated blowers shall be provided for sludge holding tanks. Operators manually select which mode to operate in from the PLC based on tank level and operational needs.

The sludge holding tanks aeration can be operated in Manual or Remote modes as described below. The blowers shall stop in any mode due a pre-programmed low-sludge level. The blower status is displayed at the PCS.

Associated PLC and RIO
80-CTRL-PLC-0001, 72-CTRL-RIO-0001

Associated Equipment
71-AIR-BL-0101, 71-AIR-BL-0201, 71-AIR-PIT-0101, 71-AIR-PIT-0201

Associated P&ID(s)
71-I-003

Local Manual Mode
Local manual control of the blowers shall be provided through a selector switch at the Blower local control panel. In local mode, the blower runs continuously until the STOP button is pushed mixer control box. When the LOR switch is in the LOCAL position, the blower shall be controlled via the local control station.

Local Auto Mode
None

Remote Manual Mode
Remote manual control for blowers shall be provided through the PLC, with manual initiation of operation at the PCS HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the LCP is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the blower shall be operated from a control station on the PCS HMI with manual input.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the LCP is in the REMOTE position and the MA selector at the PCS HMI is in AUTO, operation of the blower shall be controlled automatically by the PLC based on Intermittent Operation using operator adjustable set-points for the interval between mixer operation and duration of mixer operation; or as a continuous Operation. Base on level in the Sludge holding DO tank.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Sludge Holding Tank Blower Fail

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Sludge Holding Tank Blower In-Remote
- Sludge Holding Tank Blower Running
- Sludge Holding Tank Blower Discharge Pressure

PLC Powerup
On PLC powerup, control of the Blowers shall be set to remote manual mode.

Power Failure
Control of the blowers shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Sludge holding tank blower shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.07.03. Dewatering Sludge Feed Pumps.

The sludge dewatering system pumps waste sludge from the Sludge Holding Tanks, or directly from the MBR system, and performs dewatering to a water content suitable for hauling and disposal.

Two dewatering sludge feed pumps (Duty /Standby) each equipped with variable frequency drives (VFDs) transfer stabilized sludge from the sludge holding tanks to the belt press. Pressure is displayed locally on the pump suction and discharge of the pumps. In the event of high discharge pressure the dewatering sludge feed pump shuts down. The pumps discharge to common discharge line where the flowrate is measured, displayed locally and transmitted to the PLC.

Associated PLC and RIO
72-CTRL-PLC-0001

Associated Equipment
72-DWT-P-0101, 72-DWT-P-0201
72-DWT-VFD-0101, 72-DWT-VFD-0201, 72-DWT-FIT-0001

Associated P&ID(s)
72-I-001

Local Manual Mode
Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the VFD, START-STOP (SS) switch, and speed control potentiometer. When the LOR switch is in the LOCAL position, the pump shall be controlled via the SS control station, with speed control entered locally at the drive.

Each pump motor shall be provided with an RTD assembly. Output from the RTDs shall be routed to the VFD, which shall monitor motor temperature and provide an alarm and shutdown the drive if safe operating temperatures are exceeded.

The pumps shall be interlocked to prevent operation when their respective Suction low pressure switch, low water flow switch and high discharge pressure is active.

Each pump VFD shall generate a FAIL alarm in response to loss of operation.

Pump duty shall be rotated base on time interval manually.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the PCS HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the pump shall be operated from a control station on the PCS HMI with manual input of pump speed.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the pump/VFD is in the REMOTE position and the MA selector at the PCS HMI is in AUTO, operation of the pump shall be controlled automatically by the PLC.

Pump duty selection (Duty / Standby or set a put to be out of service) is set from the configuration screen. In the event the duty pump fails the standby pump is promoted to the duty pump role. When a pump is selected as out of service, the pump is taken out of the control loop. The pump starts, stops and speed is adjusted to maintain the input flow set point. A pressure switch located on the pump discharge generates an alarm to PCS and shuts down a pump. Discharge Flow is measured, displayed locally and transmitted to PCS.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Dewatering Sludge Feed Pump VFD Fail (each pump)

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Dewatering Sludge Feed Pump In-Remote (each pump)
- Dewatering Sludge Feed Pump Running (each pump)
- Dewatering Sludge Feed Pump Fail (each pump)
- Dewatering Sludge Feed Pump Speed (each pump)
- Dewatering Sludge Feed Pump Flow

PLC Powerup
On PLC powerup, control of the pumps shall be set to remote manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Dewatering Sludge Feed Pumps shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.07.04. Belt Filter Press.

A belt filter press with a polymer feed system performs the sludge dewatering. The thickened solids drop to a conveyor that transports them to a roll-off container. The belt filter press is designed to be operated 2 days per week, 8 hours per day.

The belt press runs continuously for the duration of the sludge processing event. The belt press, sludge feed and polymer feed system operate in Remote Auto through a master control panel (MCP). The automated startup and shutdown sequences for the components are managed by the MCP. The polymer dosage and belt speed are adjusted by the Plant Operator.

Operators will manually valve the Sludge Pumps to draw from the desired Sludge Holding Tank, manually operate the Sludge Pumps, and manually operate the Belt Filter Press equipment.

Associated PLC and RIO
72-CTRL-RIO-0001, 80-CTRL-PLC-0001

Associated Equipment
72-DWT-BFPS-0001, 72-DWT-HPU-0001, 72-DWT-COS-0001, 72-DWT-COS-0002, 72-DWT-COS-0003, 72-DWT-P-0001, 72-DWT-V-0001

Associated P&ID(s)
72-I-002

Local Manual Mode
Local manual control of the belt filter press shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the local control panel. In Local Manual

Mode, the conveyors are controlled using Start and Stop switches; in Off the conveyors do not run.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the PCS HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the local control panel is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the belt filter press shall be operated from a control station on the PCS HMI with manual input.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the local control is in the REMOTE position and the MANUAL-AUTO selector at the PCS HMI is in AUTO, operation shall be controlled automatically by the PLC.

The Belt Filter Press LCP controls dewatering operating using a control selector switch. In the ON position, the dewatering system starts by starting the cake conveyors and opening the dumpster gates. The plant service water solenoid valve opens to supply the two-belt press washwater boxes. The drive motors start, which moves the belts through the wash boxes to wet the belt. The PSW line has a low-pressure switch that shuts down the belt press in the event there is insufficient water pressure to clean the belts. The polymer feed system is then called to operate (the polymer metering pump must be in Auto control). The dewatering system does not run if the control selector switch is in the OFF position. An E-Stop is also located on the Dewatering LCP and will stop the dewatering option if the button is pushed.

An inclined screw conveyor transports cake to the single-port dumpster distribution screw conveyor. A motorized gate is located on the bottom of the shaftless conveyor that permits the cake to fall into the dumpster. Each conveyor is controlled as part of the dewatering start and stop sequence.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Belt Filter Press Fail
- Belt Filter Press Shutdown Alarm
- Belt Filter Press E-Stop
- Washwater Pressure Low
- Washwater Pump Fail
- Conveyors Zero Speed
- Conveyors Motor Overload

- Conveyors E-Stop

Status Indications
The HMI shall indicate the following statuses at a minimum:
- Belt Filter Press Running
- Conveyors Running
- Belt Filter Press Supply Valve Status

PLC Powerup
TBC

Power Failure
Control of the Belt filter press shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Dewatering Belt filter press shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.07.05. SAFE System.

The SAFE system uses cloth media filtration to provide side-stream treatment of peak flows for blending with effluent from the MBR system and discharge to the ocean. The SAFE system box sends flow exceeding the MBR capacity to the SAFE system by gravity. A concrete tank, called the SAFE Settle, is located upstream of the SAFE Filter. The SAFE Settle basin captures and equalizes peak event flows. Many of the smaller peak flow events will not completely fill the SAFE Settle basin and therefore would not go to the SAFE Filter System. Water from these events shall be pumped back to the headworks for treatment when plant flows have decreased.

In larger peak flow events, water fills the SAFE Settle basin until it passes over a weir and flows to the SAFE Filter System for filtration treatment. During this operation, the Safe Settle basin provides some sedimentation treatment upstream of the Safe Filter System. Effluent from the SAFE Filter System is routed to the Outfall Balancing Tank where it is blended with MBR effluent and pumped by the Outfall Pump Station to the Outfall Disinfection Pipeline Contactor and then onto the Ocean Outfall.

The SAFE filter system is always online so when water starts flowing to the system, backwash can operate. The SAFE filter system includes a backwash drive and pumps which start automatically as required during operation of the

SAFE Filter system. Backwash waste is pump to the Fine Screens Influent for treatment by the BNR system.

The SAFE System shall be managed by the SAFE-Filter System Suppliers standard controls and logic. Control information provided herein is for information only and is a general description of the operating strategy of the system. This description is subject to change to conform to the SAFE-Filter system suppliers' standards and typical operating approach.

SAFE-Settle Monitoring

- The level in the SAFE-Settle Tank is monitored and recorded on PCS.
- When the level is greater than pre-programmed level (corresponding to the SAFE-Settle Overflow Weir Level) – a "Flow to SAFE-Filter" notification shall be indicated on the PCS.

SAFE-Filter Controls

The SAFE-Filter is operated based on the System Suppliers typical control algorithm.

- Filtration
  - In Filtration mode, filtration occurs without interruption while the disk filters are submerged. Filtered water collects in a center tube and exits through an effluent weir.

- Filter Backwash
  - When the head loss in the SAFE-Filter exceeds a pre-programmed set point (system supplier specific), the filter will backwash.
  - The head loss set point is overridden in the event that a pre-determined interval between backwashes is exceeded.

- Solids Wasting
  - Solids wasting from the bottom of the SAFE-Filter is triggered based on a pre-programmed number of backwash cycles between solids wasting.

- Floatables / Scum Wasting.
  - After a preset number of backwashes, the water level is allowed to rise above the preset high level and the scum flows over the scum removal weir. Scum wasting water is directed to the plant drain.

3-4.07.06. SAFE System – Discharge Flow SAFE Flow Monitoring. The SAFE-Filter Effluent Flow (QSAFE.EFF) is calculated using the SAFE-Filter Effluent

Flowmeter reading 73-FSW-FIT-0001. The SAFE-Filter Influent Flow shall be used to calculate:

- Daily Total SAFE Filter Influent Volume.

Associated PLC and RIO
72-CTRL-RIO-0001, 80-CTRL-PLC-0001

Associated Equipment
73-FSW-FLT-000173-FSW-P-0001, 73-FSW-P-0002

Associated P&ID(s)
73-I-001

Local Manual Mode
Local manual control of the Safe system shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch at the local control panel.

Disk filter inlet modulating gate shall be operated from the valve actuator.

In Local Manual Mode, the disk filter, filter solid waste pump and filter backwash waste pump are controlled from VFD faceplates at local control panel.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC, with manual initiation of operation at the PCS HMI. Provide a control station at the PCS HMI with selectable MANUAL-AUTO (MA) modes. When the LOR selector switch at the local control panel is in the REMOTE position and the MA selector at the PCS HMI is MANUAL, the operation of the disk filter press shall be operated from a control station on the PCS HMI with manual input. Scum valve, filter solids waste pump and filter backwash waste pump shall be controlled from PCS HMI.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch at the local control is in the REMOTE position and the MANUAL-AUTO selector at the PCS HMI is in AUTO, operation shall be controlled automatically by the PLC. Scum valve, filter solids waste pump and filter backwash waste pump shall be controlled from PCS HMI.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Disk Filter Fail
- Disk Filter High Flow

- Disk Filter High Level
- Disk Filter Vibration High
- Filter Backwash Waste Pumps Fail
- Filter Backwash Waste Pumps High Pressure

Status Indications
The HMI shall indicate the following statuses at a minimum:
- Disk Filter In Remote
- Disk Filter Running
- Disk Filter Level
- Disk Filter Effluent Flow
- Disk Filter Vibration
- Disk Filter pH
- Filter Backwash Waste Pumps In Remote
- Filter Backwash Waste Pumps Running
- Filter Backwash Waste Pumps Flow
- Filter Backwash Waste Pumps Pressure
- Valves Status

PLC Powerup
TBD

Power Failure
Control of the Safe system shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Safe System shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.08. ELECTRICAL SYSTEMS – AREA 80.

3-4.08.01. Generator System.

Associated Equipment
81-GEN-GEN-0001, 81-GEN-TNK-0001, 81-GEN-ATS-0001

Associated PLC and RIO
80-CTRL-PLC-0001

Associated P&ID(s)
81-I-001

Local Manual
The manual mode shall allow an operator to select manual operation for controlling and monitoring the backup power system independent of any automatic control logic functions. All connections shall be hardwired between the monitoring and control devices and the equipment being monitored and controlled. The switchgear and generators shall be furnished with all necessary monitoring and control components to allow manual mode operation of the entire system.

In addition, power transfer controls shall be furnished. The power transfer controls shall include all devices necessary for monitoring and controlling the switchgear feeder circuit breakers. The transfer controls shall include all devices necessary to allow the operator to control and monitor the backup generator set. The switchgear and generator shall include a graphical operator panel for power transfer and paralleling controls.

Local Auto
Local automatic control shall be provided through the automatic transfer controller. Refer to Section 16346 – Paralleling Switchgear, and Section 11910 - Engine-Generators.

Remote Manual
None

Remote Auto
None

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Fuel Level High-High
- Fuel Level Low
- Fuel Leak Detected
- Engine Generator Fail
- Engine Generator Running
- Engine Generator Breaker Open
- Engine Generator Breaker Closed
- Engine Generator Battery Fail
- Engine Generator ATS Fail
- Normal Power
- Generator Power

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Engine Generator Power Factor (0-1)
- Engine Generator Power (KW)

- Engine Generator Voltage
- Engine Generator Volt-Amps

HMI Requirements
The Generation System shall be depicted on the generator system display. The display layout shall be similar to that indicated on the P&ID and shall indicate all alarms and statuses indicated above.

Calculations
None.

3-4.08.02. Switchboard and Motor Control Center Power Monitoring.

Associated Equipment
80-ELEC-SWB-0001, 80-ELEC-MCC-0001, 80-ELEC-MCC-0002, 50-ELEC-MCC-0002

Associated PLC and RIO
80-CTRL-PLC-0001, 50-CTRL-PLC-0001

Associated P&ID(s)
81-I-002

Local Manual
None

Local Auto
None

Remote Manual
None

Remote Auto
None

Alarms:
The HMI shall indicate the following alarms at a minimum:
- None

Status Indications:
The HMI shall indicate the following statuses at a minimum for all MCC and Switchboards listed above and covered on P&ID:
- Phase Current (for all 3 phases)
- Phase Voltage (for all 3 phases)

- MCC/SWD Power (KW)
- MCC/SWD Volt-Amps
- MCC/SWD Power Factor
- MCC/SWD Power Watt Hours
- MCC/SWD Watt Demand
- MCC/SWD Frequency

HMI Requirements
The power monitoring for all MCC/ switchboards shall be shown on the power system display.

Calculations
None.

3-4.09. CHEMICAL AREA – AREA 90.
Several chemicals are added to the treatment process for a variety of purposes from MBR cassettes and RO membranes cleaning, sludge thickening and water disinfection.

3-4.09.01. Sodium Hypochlorite Storage and Feed System (Speed Control Only, Peristaltic).

One hypochlorite bulk storage tank is being provided to store 12.5 percent solution. Sodium hypochlorite can degrade over time, the values used to calculate pump sizes and storage volumes were assumed to be at less than full strength to ensure adequate capacity. The storage tank is sized to hold 15 days of storage or approximately one full tanker delivery, whichever is greater. The metering pumps are peristaltic pumps designed to feed chemical over the full range of plant flows and doses.

Sodium hypochlorite shall be injected in the UV influent header downstream of the sulfuric acid dosing location. Dosing shall be based on the flow signal from the duty UV reactor and free chlorine residual. Primary control of the sodium hypochlorite dosing pump shall be based on the free chlorine residual as calculated by the difference between total chlorine measured upstream and downstream of the sodium hypochlorite injection point. Secondary control of the sodium hypochlorite dosing pump shall be based on free chlorine measured at the inlet to the duty UV reactor.

The UV MCP/LCP shall be programmed with minimum and maximum free chlorine alarm set points to ensure the target treatment goal is achieved and to protect the UV reactors from potential damage due to chlorine oxidation. Sodium hypochlorite dosing shall maintain the free chlorine concentration within those limits. The UV MCP shall communicate the free chlorine alarm to the PCS. In the

event the flow signal from the duty UV reactor is lost, sodium hypochlorite dosing shall be scaled based on the sum of the ROP flow signals.

Sodium hypochlorite shall be injected in the RO feed downstream RO feed tanks and upstream of the sodium hypochlorite injection point. Primary dosing shall be based on the feed flow signals from the in-service RO units. Sodium hypochlorite dosing shall be secondary controlled off measured free chlorine residual. The MCP/LCP shall be programmed with a maximum free chlorine alarm set point to protect the RO elements from potential damage due to chlorine oxidation.

Associated Equipment
NOCL-P-0101, NOCL-P-0201, NOCL-P-0301, NOCL-P-0401, NOCL-P-0501, NOCL-P-0601, NOCL-P-0701

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-001

Associated P&ID(s)
90-I-001, 90-I-002

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LCOAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the high discharge pressure switch trips and when a tube leak is detected.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tank level falls below an adjustable low level.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the

pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is selected at the HMI, the pump shall run and pump output (feed rate) shall be controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the Sodium hypochlorite at following points.

- To Ocean Outfall Piping
- To RO Concentrate Water Piping
- To RO Feed Piping
- To UVAOP System
- Disinfection of RO Product Water
- To MBR backwash / CIP
- To Onsite Recycled Water Pumps

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail (each pump)
- Sodium Hypochlorite Level High-High
- Sodium Hypochlorite Level High
- Sodium Hypochlorite Level Low
- Sodium Hypochlorite Level Low-Low
- Feed Pump Leak (each pump)
- Feed Pump High Pressure (each pump)

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Sodium Hypochlorite Level
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the sodium hypochlorite feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of sodium hypochlorite concentration and density. The control overlay display shall also provide for automatic mode selection (flow proportional/feedback control), dosage, timer set points, and chlorine residual set point adjustment, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage - Chlorine dosage (ppm, adjustable at the HMI)
Flowrate - Process flow at feed point (MGD)
Conc - Chlorine concentration expressed as a decimal (adjustable at the HMI)
Density – Sodium Hypochlorite density (adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

Pump Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (percent)

SP = [FR x 100%] / FR(Max)

3-4.09.02. Sodium Hydroxide Storage and Feed System (Speed Control Only, Peristaltic).

One hydroxide bulk storage tank shall be provided to store 25 percent solution. This solution strength was selected to prevent the need for heat tracing the tank and piping while still maintaining a reasonable volume of storage. This tank will supply all the pumps which feed hydroxide throughout the site. The tank is sized

to hold 15 days of storage or approximately one full tanker delivery, whichever is greater. The metering pumps shall be peristaltic pumps designed to feed chemical over the full range of plant flows and doses.

Associated Equipment
NOAH-P-0101, NOAH-P-0201, NOAH-P-0301

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-001

Associated P&ID(s)
90-I-003

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LCOAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the high discharge pressure switch trips and when a tube leak is detected.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tank level falls below an adjustable low level.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is

selected at the HMI, the pump shall run and pump output (feed rate) shall be controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the Sodium hypochlorite at following points.

- To RO CIP / Neutralization Tank
- To Product Water Tank
- To Fine Screen Effluent

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail (each pump)
- Sodium Hydroxide Storage Tank Level High-High
- Sodium Hydroxide Storage Tank Level High
- Sodium Hydroxide Storage Tank Level Low
- Sodium Hydroxide Storage Tank Level Low-Low
- Feed Pump Leak (each pump)
- Feed Pump High Pressure (each pump)

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Sodium Hydroxide Storage Tank Level
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the sodium hypochlorite feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of sodium hydroxide concentration and density. The control overlay display shall also provide for automatic mode selection (flow proportional/feedback control), dosage, timer set points, and chlorine residual set point adjustment, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage – Sodium Hydroxide dosage (ppm, adjustable at the HMI)
Flowrate - Process flow at feed point (MGD)
Conc – Sodium Hydroxide concentration expressed as a decimal (adjustable at the HMI)
Density – Sodium Hydroxide density (adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

Pump Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (percent)

SP = [FR x 100%] / FR(Max)

3-4.09.03. Sodium Bisulfite Storage and Feed System (Speed Control Only, Peristaltic).

One sodium bisulfite feed system shall be provided to feed 38% chemical upstream ocean outfall termination point to prevent chlorinated water from entering the ocean. Sodium bisulfite shall be delivered and stored in a standard 330-gallon Intermediate Bulk Container (IBC) which shall be located on top of a secondary containment tub. The metering pumps shall be peristaltic pumps designed to feed chemical over the full range of plant flows and doses. Above grade sodium bisulfite piping shall be heat traced and insulated.

As bisulfite needs to be fed continuously, the system shall be equipped with a small tank in the pump suction piping that can be gravity filled from the tote as the tote is low. This will allow pumps to pull fluid from this tank while the tote is being switched out to maintain continuous operation.

Associated Equipment
NHS-P-0001, NHS-P-0002

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-001

Associated P&ID(s)
90-I-004

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LOCAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the high discharge pressure switch trips and when a tube leak is detected.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tote weight falls below an adjustable low limit. The PLC shall also generate an automatic pump stop on an adjustable low weight below the alarm level in the tote.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is selected at the HMI, the pump shall run and pump output (feed rate) shall be controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the Sodium bisulfite at following points.

- To Dechlorination to ocean outfall piping

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail (each pump)
- Sodium Bisulfite Storage Tote Weight High-High
- Sodium Bisulfite Storage Tote Weight High
- Sodium Bisulfite Storage Tote Weight Low
- Sodium Bisulfite Storage Tote Weight Low-Low
- Feed Pump Leak (each pump)
- Feed Pump High Pressure (each pump)

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Sodium Bisulfite Storage Tote Weight
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the sodium sulfite feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of sodium bisulfite concentration and density. The control overlay display shall also provide for automatic mode selection (flow proportional/feedback control), dosage, timer set points, and chlorine residual set point adjustment, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage – Sodium Bisulfite dosage (ppm, adjustable at the HMI)
Flowrate - Process flow at feed point (MGD)
Conc – Sodium Bisulfite concentration expressed as a decimal (adjustable at the HMI)
Density – Sodium Bisulfite density (adjustable at the HMI)
FR - Feed rate (gallons/hour)
FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

Pump Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (percent)

SP = [FR x 100%] / FR(Max)

3-4.09.04. Antiscalant Storage and Feed System (Speed Control Only, Peristaltic).

One antiscalant system shall be provided to feed chemical upstream of the RO system. Antiscalant shall be delivered and stored in a standard 330-gallon Intermediate Bulk Container (IBC) which shall be located on top of a secondary containment tub. The metering pumps shall be peristaltic pumps designed to feed chemical over the full range of plant flows and doses.

Antiscalant (Threshold Inhibitor) – Added to the RO system feed water to minimize inorganic scaling on the membranes.

Antiscalant shall be injected in the RO feed downstream of the sodium hypochlorite injection point described above. Dosing shall be based on the feed flow signals from the in-service RO units and user set points for target antiscalant concentration (default 3-5 mg/L).

Associated Equipment
ANTI-P-0101

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-001

Associated P&ID(s)
90-I-005

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LOCAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the high discharge pressure switch trips and when a tube leak is detected.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tote weight falls below an adjustable low limit. The PLC shall also generate an automatic pump stop on an adjustable low weight below the alarm level in the tote.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is selected at the HMI, the pump shall run and pump output (feed rate) shall be controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the Sodium bisulfite at following points.

- To Common RO Header

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail (each pump)
- Antiscalant Storage Tote Weight High-High
- Antiscalant Storage Tote Weight High
- Antiscalant Storage Tote Weight Low
- Antiscalant Storage Tote Weight Low-Low
- Feed Pump Leak (each pump)
- Feed Pump High Pressure (each pump)

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Antiscalant Storage Tote Weight
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the Antiscalant feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of Antiscalant concentration and density. The control overlay display shall also provide for automatic mode selection (flow proportional/feedback control), dosage, timer set points, and chlorine residual set point adjustment, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage - Antiscalant dosage (ppm, adjustable at the HMI)

Flowrate - Process flow at feed point (MGD)
Conc - Antiscalant concentration expressed as a decimal (adjustable at the HMI)
Density - Antiscalant density (adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

Pump Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (percent)

SP = [FR x 100%] / FR(Max)

3-4.09.05. Citric Acid Storage and Feed System (Speed Control Only, Peristaltic).

One citric acid feed system shall be provided to feed 50% chemical to both the RO and MBR systems for periodic cleaning of the membrane systems and neutralization of the cleaning solution prior to discharge. Citric shall be delivered and stored in a standard 330-gallon Intermediate Bulk Container (IBC) which shall be located on top of a secondary containment tub. The dedicated metering pumps shall be peristaltic pumps designed to feed chemical over the full range of plant flows and doses.

Associated Equipment
CA-P-0101, CA-P-0201

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-001

Associated P&ID(s)
90-I-006

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LOCAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the high discharge pressure switch trips and when a tube leak is detected.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tote weight falls below an adjustable low limit. The PLC shall also generate an automatic pump stop on an adjustable low weight below the alarm level in the tote.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is selected at the HMI, the pump shall run and pump output (feed rate) shall be controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the citric acid at following points.

- To RO CIP system
- To MBR Maintenance main

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail (each pump)
- Citric Acid Storage Tote Weight High-High
- Citric Acid Storage Tote Weight High
- Citric Acid Storage Tote Weight Low
- Citric Acid Storage Tote Weight Low-Low
- Feed Pump Leak (each pump)
- Feed Pump High Pressure (each pump)

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Citric Acid Storage Tote Weight
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the citric acid feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of citric acid concentration and density. The control overlay display shall also provide for automatic mode selection (flow proportional/feedback control), dosage, timer set points, and chlorine residual set point adjustment, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage – Citric Acid dosage (ppm, adjustable at the HMI)
Flowrate - Process flow at feed point (MGD)
Conc – Citric Acid concentration expressed as a decimal (adjustable at the HMI)
Density – Citric Acid density (adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

Pump Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (percent)

SP = [FR x 100%] / FR(Max)

3-4.09.06. Sulfuric Acid Storage and Feed System (Speed Control Only, Peristaltic).

One sulfuric acid feed system shall be provided to feed a dilute solution of chemical to the RO / UVAOP system. Sulfuric acid shall be delivered and stored in a standard 330-gallon Intermediate Bulk Container (IBC) at 93% solution strength which shall be located on top of a secondary containment tub. The metering pumps will not be peristaltic pumps as used elsewhere in the plant as this type of pump is not recommended for concentrated sulfuric acid. These pumps will instead be diaphragm metering pumps designed to feed chemical over the full range of plant flows and doses and will feed into a dilution panel capable of diluting down the chemical to approximately 5-10% solution strength. This dilution will help to mitigate any problems should a minor leak occur as the chemical is routed through the site.

Sulfuric acid shall be injected in the UV influent header just upstream of the sodium hypochlorite injection point described below. The purpose of the acid addition at this location is to ensure the free chlorine is in the hypochlorous acid form which is a slow hydroxyl radical scavenger compared to hypochlorite ion which occurs at higher pH values. Dosing shall be based on the flow signal from the duty UV reactor and the pH measured in the influent header post the sodium hypochlorite dosing point.

The UV MCP/LCP is programmed for a target pH using an operator defined set point; default value per the equipment supplier's requirements. The UV MCP/LCP is programmed with minimum and maximum pH alarms set points to ensure the target treatment goal is achieved. Sulfuric acid dosing will maintain the pH within those limits. The UV MCP shall communicate the pH alarm to the PCS. In the event the flow signal from the duty UV reactor is lost, sulfuric acid dosing shall be scaled based on the sum of the ROP flow signals.

Sulfuric acid shall be injected in the RO feed downstream RO feed tanks and upstream of the sodium hypochlorite injection point described below. The purpose of the sulfuric acid addition at this location is to suppress the pH of the RO feed to inhibit scaling of sparingly soluble salts. Dosing shall be based on the flow signal from the RO influent flow meter and the pH measured in the influent header post the sodium hypochlorite dosing point.

The RO MCP is programmed for a target pH using an operator defined set point; default value per the RO and antiscalant manufacturer projection results. The RO MCP is programmed with minimum and maximum pH alarms set points to ensure the target treatment goal is achieved. Sulfuric acid dosing will maintain the pH within those limits. The RO MCP shall communicate the pH alarm to the PCS.

Associated Equipment
HSO4-P-0101, HSO4-P-0201

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-001

Associated P&ID(s)
90-I-007

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LOCAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the high discharge pressure switch trips and when a tube leak is detected.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tote weight falls below an adjustable low limit. The PLC shall also generate an automatic pump stop on an adjustable low weight below the alarm level in the tote.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is selected at the HMI, the pump shall run and pump output (feed rate) shall be

controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the sulfuric acid at following points.

- To RO feed tank outlet piping
- To UV / AOP System

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail (each pump)
- Sulfuric Acid Storage Tote Weight High-High
- Sulfuric Acid Storage Tote Weight High
- Sulfuric Acid Storage Tote Weight Low
- Sulfuric Acid Storage Tote Weight Low-Low
- Feed Pump Leak (each pump)
- Feed Pump High Pressure (each pump)

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Sulfuric Acid Storage Tote Weight
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the citric acid feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of sulfuric acid concentration and density. The control overlay display shall also provide for automatic mode selection (flow proportional/feedback control), dosage, timer set points, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage – Sulfuric Acid dosage (ppm, adjustable at the HMI)
Flowrate - Process flow at feed point (MGD)
Conc – Sulfuric Acid concentration expressed as a decimal (adjustable at the HMI)
Density – Sulfuric Acid density (adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

Pump Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (percent)

SP = [FR x 100%] / FR(Max)

3-4.09.07. Thickening Polymer Storage and Feed System (Speed Control Only, Peristaltic).

One polymer system shall be provided to mix and feed an emulsion polymer with potable water. This solution shall be fed to the belt filter press to assist with cake formation. As mentioned above, the polymer storage tote and feeder / blender system shall be located in the Dewatering Area adjacent to the press. Chemical shall be delivered and stored in a standard 330-gallon Intermediate Bulk Container (IBC) which shall be located on top of a secondary containment tub. The polymer feeder / blender skid shall be a standard system provided by a manufacturer of these types of systems. The pump provided on the feeder / blender skid shall be specified as a peristaltic pump to be similar to those used for other chemical applications. This system will dilute polymer down to approximately a 0.5 - 1% solution for feeding into the press at the required flow.

Polymer is added to the sludge feed to enhance coagulation. Dosage is based on the sludge feed rate and is set through the vendor supply LCP.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the low dilution water pressure switch trips and when a tube leak is detected.

Associated Equipment
POLF-P-0101

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-0001

Associated P&ID(s)
90-I-008

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LOCAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tote weight falls below an adjustable low limit. The PLC shall also generate an automatic pump stop on an adjustable low weight below the alarm level in the tote.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is selected at the HMI, the pump shall run and pump output (feed rate) shall be

controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the sulfuric acid at following points.

- To Belt Filter Press No.1

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail (each pump)
- Polymer Storage Tote Weight High-High
- Polymer Storage Tote Weight High
- Polymer Storage Tote Weight Low
- Polymer Storage Tote Weight Low-Low
- Feed Pump Leak (each pump)
- Feed Pump High Pressure (each pump)

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Polymer Storage Tote Weight
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the citric acid feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of polymer concentration and density. The control overlay display shall also provide for

automatic mode selection (flow proportional/feedback control), dosage, timer set points, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage - Polymer dosage (0-XX lbs/dt of solids, adjustable at the HMI)
Flowrate - Sludge flow at feed point (gpm)
ConcP – Neat polymer concentration expressed as a decimal (adjustable at the HMI)
DensityP – Neat polymer density (adjustable at the HMI)
ConcS – Residuals solids concentration expressed as a decimal (adjustable at the HMI)
DensityS – Solids density (adjustable at the HMI)
Dilution – Dilution rate of neat polymer expressed as a decimal (adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Flowrate x ConcS x DensityS x 60 min/hr / 2000 lb/ton] x [Dosage / DensityP x ConcP x Dilution]

Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (%, calculated)

SP = [FR / FR(Max)] X 100%

3-4.09.08.Liquid Ammonia Sulfate Storage and Feed System (Speed Control Only, Peristaltic).

One Liquid Ammonia Sulfate feed system shall be provided to feed a dilute solution of chemical to the RO / UVAOP system. Liquid ammonia sulfate shall be delivered and stored in two standard 330-gallon Intermediate Bulk Container (IBC).

Associated Equipment
90-LAS-P-0001

Associated PLC and RIO
80-CTRL-PLC-0001, 90-CTRL-RIO-001

Associated P&ID(s)
90-I-009

Local Manual Mode
Local Manual control of the metering pump shall be provided through a LOCAL-OFF-REMOTE (LOR) switch on the metering pump integral control panel. When the LOR switch is in the LOCAL position the pump shall run and speed shall be controlled using the local adjustment devices on the metering pump control panel. When the LOR switch is in the OFF position the pump shall stop.

The metering pump shall have hardwired interlocks in all control modes to stop the pump when the high discharge pressure switch trips and when a tube leak is detected.

Local Auto Mode
None

Remote Manual Mode
Remote manual control shall be provided through the PLC. When the LOR selector switch at the pump is in the REMOTE position and MANUAL is selected at the HMI, the pump ON/OFF shall be controlled from the HMI using operator manual commands, and speed shall be manually adjusted at the HMI.

In all remote control modes, a PLC generated alarm shall be provided when the storage tote weight falls below an adjustable low limit. The PLC shall also generate an automatic pump stop on an adjustable low weight below the alarm level in the tote.

In all remote control modes, when a metering pump is running a timer shall be invoked to monitor the period of time any pump is running. The timer shall automatically stop and reset when the metering pump is stopped. If any metering pump run timer has exceeded an adjustable time period set point, the pump shall stop, and the PLC shall generate an excessive metering pump runtime alarm to the HMI. A manual HMI reset shall be required to restart the pump.

Remote Auto Mode
Remote automatic control shall be provided through the PLC. When the LOR selector switch for the metering pump is in the REMOTE position and AUTO is selected at the HMI, the pump shall run and pump output (feed rate) shall be controlled by the flow pacing signal and the dosage calculated by a Proportional Integral controller.

Dedicated Pump will dose the Liquid Ammonia sulfite at following points.

- To Common RO pump feed Header

Transfer between manual and automatic modes of the controller shall be bumpless.

Alarms:
The HMI shall indicate the following alarms at a minimum:

- Feed Pump Fail
- Liquid Ammonia sulfite Storage Tote Weight High-High
- Liquid Ammonia sulfite Storage Tote Weight High
- Liquid Ammonia sulfite Storage Tote Weight Low
- Liquid Ammonia sulfite Storage Tote Weight Low-Low
- Feed Pump Leak
- Feed Pump High Pressure

Status Indications:
The HMI shall indicate the following statuses at a minimum:

- Liquid Ammonia Sulfite Storage Tote Weight
- Feed Pump Speed (0-100%) (each pump)
- Feed Pump Running (each pump)
- Feed Pump In-Remote (each pump)
- Feed Pump In-Manual (each pump)
- Feed Pump In-Auto (each pump)

PLC Power-Up
On PLC power-up, control of the pump shall be set to remote manual mode.

Power Failure
Control of the pump shall resume with the control mode established prior to the power failure.

HMI Requirements
The metering pump shall be depicted on the Liquid Ammonia sulfite feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (man/auto), manual control (ON/OFF and liters per hour adjustment), pump capacity [FR(MAX)], and shall duplicate status indication as shown on the main display.

A separate control overlay display shall be provided for operator entry of Liquid Ammonia sulfite concentration and density. The control overlay display shall also provide for automatic mode selection (flow proportional/feedback control), dosage, timer set points, and chlorine residual set point adjustment, and PID tuning parameter adjustment.

Access to pump capacity adjustment, PID tuning parameters, and chemical concentration and density set points shall be at the engineer's security level.

Calculations
Feed Rate Calculation:
Dosage - Liquid Ammonia sulfite dosage (ppm, adjustable at the HMI)

Flowrate - Process flow at feed point (MGD)
Conc - Liquid Ammonia sulfite concentration expressed as a decimal (adjustable at the HMI)
Density - Liquid Ammonia sulfite density (adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

Pump Speed Calculation:
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
SP - Speed (percent)

SP = [FR x 100%] / FR(Max)

3-4.10. Small Packaged Pump Systems.

The following pump stations are small packaged systems that operate on level and are lead/lag.

3-4.10.01. Storm Basin Outlet Control and Pump Station.

The Storm Basin Outlet Control and Pump Station collects site stormwater and pumps it to the Sanitary Pump Station.

Associated PLC and RIO
None

Associated Equipment
95-STW-P-0101

Associated P&ID(s)
95-I-001

Local Manual Mode
Local manual control of the pump shall be provided through the START-STOP (SS) switch manually.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
None.

Status Indications
None.

PLC Powerup
None.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Storm Basin Outlet Control and Pump Station shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

3-4.10.02. Sanitary Lift Pumping Station Pumps.

The Sanitary Lift Pumping Station pumps waste sewer from the pumping station wet well to headworks.

Associated PLC and RIO
80-CTRL-PLC-0001, 51-CTRL-RIO-0001

Associated Equipment
95-SAN-P-0101, 95-SAN-P-0201
95-SAN-LCP-0001

Associated P&ID(s)
95-I-001

Local Manual Mode
Local manual control of the pumps shall be provided through the LOCAL-OFF-REMOTE (LOR) selector switch, START-STOP (SS) switch. When the LOR switch is in the LOCAL position, the pump shall be controlled via the SS control station.

The pumps shall be interlocked to prevent operation when their respective low wet well level.

LCP shall generate a FAIL alarm in response to loss of operation.

Pump duty shall be rotated base on time interval manually.

Local Auto Mode
None.

Remote Manual Mode
None.

Remote Auto Mode
None.

Alarms
The HMI shall indicate the following alarms at a minimum:

- Sanitary Lift Pump Station Fail
- Sanitary Lift Pump Station Level High

Status Indications
The HMI shall indicate the following statuses at a minimum:

- Sanitary Pump 1 or 2 Running

PLC Powerup
On PLC powerup, control of the pumps shall be set to local manual mode.

Power Failure
Control of the pumps shall resume with the control mode established prior to the power failure.

PCS HMI Requirements
The Sanitary Lift Pumping Station shall be depicted on the display. The display layout shall be similar to the P&ID.

Calculations
None.

End of Section

Section 40 69 13

UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1-1. SCOPE. The Uninterruptible Power Supply section covers the furnishing of a complete on-line uninterruptible power supply (UPS) as indicated on the Drawings.

The system shall convert incoming single phase, 60 Hz, power into dc power, maintain and charge backup batteries and reconvert outgoing power into a sinusoidal single phase, 60 Hz, ac power source. The system shall consist of a rectifier, battery charger, batteries, inverter, integral static bypass switch, and maintenance bypass switch as required.

Additional accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.

1-1.01. Control System. The Instrumentation and Control System section shall apply to all equipment furnished under the Uninterruptible Power Supply section.

1-1.02. Control System Loads. The UPS shall supply the Control System and other loads located in or external to the control room and server room as indicated on the Drawings.

1-2. GENERAL. Equipment furnished under the Uninterruptible Power Supply section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Drawings. Supplementing this section, the Drawings indicate locations and arrangement of enclosures and provide one-line diagrams regarding the connection and interaction with other equipment.

1-2.03. Nameplates. Each UPS shall be identified with a suitable engraved nameplate mounted on the top front. A nameplate shall also be provided for each of the external manual bypass switches. The nameplates shall be made of laminated black and white plastic. The lettering shall be bold, not less than

1/4 inch square, engraved by cutting through the black outside layer so that the letters appear white.

1-3. SUBMITTALS. In addition to the Instrumentation and Control System section, all material and equipment documentation shall be submitted for review as specified in the Submittals Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

a. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which equipment applies.

b. Sheets or drawings showing items not applicable to this system, or not requiring review, shall contain clear indication as to which section or sections require review.

c. Functional line diagrams showing all major system components and external connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

d. A report certifying that the UPS will provide the required backup time at the specified UPS loading and UPS ambient temperature. The report shall include anticipated continuous electrical load calculations, backup time calculations and shall indicate the battery end-voltage used in the analysis.

1-4. DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System section.

1-5. SPARE PARTS. The System Supplier shall provide spare parts per the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. GENERAL. All equipment, enclosures, and accessories shall be designed, assembled and connected in accordance with the requirements of these Specifications and the Drawings. Enclosures shall be NEMA Type 1.

2-1.01. System Design Requirements. The UPS system(s) have the following capacity and rated for the following voltages.

Capacity	2 kW
Input voltage at 60 Hz, +10 to -15 percent	120
Output voltage at 60 Hz single phase	120
Minimum Back up time required (minutes)	10

The UPS system(s) shall ratings and features.

Capacity, peak (minimum)	150 percent of continuous power rating for 10 seconds.
Frequency stability, battery mode	± 0.5 percent.
Harmonic distortion (max)	5 percent.
Efficiency, overall on-line	75 percent minimum.
Operating temperature-humidity	0 to 40°C; 0 to 95 percent relative humidity, non-condensing.
Recharge time (max)	4 hours.

2-1.02. Acceptable Manufacturers. All systems supplied under this contract shall be of the same manufacturer. The uninterruptible power supply systems shall be as manufactured by MGE, Powerware, Liebert, or equal.

2-1.03. Terminal Blocks. Wiring for external circuits, including all alarm contacts, shall be brought to grouped terminal blocks located for convenient connection. Provisions shall include suitable marked terminal blocks for connection of No. 12 AWG control wiring and for input/output power conductors as sized on the Drawings. Terminal designations shall agree with manufacturer's wiring diagram.

2-2. BATTERY CHARGER/RECTIFIER AND BATTERIES. The battery charger and the rectifier shall have the following characteristics:

a. The rectifier shall convert the incoming ac power to dc power to energize the static inverter.

b. The battery charger shall supply a float current to the batteries to maintain them at a fully charged state while incoming power is being provided. The charging voltage shall be temperature-compensated over the entire operating temperature range to avoid overcharging or undercharging the batteries. The battery charger shall automatically apply an elevated voltage (equalization charge) to the batteries if and as required by the battery manufacturer.

c. The battery shall provide backup power for the UPS when incoming commercial power is not available. The battery cells shall be valve-regulated or gelled-electrolyte lead-acid type. The

battery shall be integral to the UPS. Battery shall have capacity to supply the dc power to the UPS while operating at full load for a period of not less than as required at 25°C. The battery shall have an expected life of 5 years and shall carry a one-year warranty.

2-3. STATIC INVERTER. The solid-state inverter shall employ silicon-controlled rectifiers (SCRs) and other devices for converting direct current power to essentially sinusoidal alternating current power. The static inverter shall conform to the following characteristics and requirements.

a. Automatic Synchronization: During normal operation, the inverter shall provide power to critical loads. The utility electric system will act as an alternate supply. Inverter equipment shall include stable solid-state devices designed to automatically maintain inverter output in phase with the utility electric system.

b. Overload, Short Circuit, and Load Loss: The inverter shall have input and output fuses and other equipment necessary to protect from overload, short circuit, and 100 percent loss of load. Current limiting features shall also be provided.

c. Loss of Supply Voltages: The inverter shall include protective devices to prevent damage resulting from excursion, loss, or restoration of its synchronization voltage and its dc input voltage and any inrush current occurrences associated with such conditions.

2-4. STATIC TRANSFER SWITCH. The static transfer switch shall use SCRs and other static devices to automatically transfer loads from the off-line (bypass) to the on-line operating condition and back again. In off-line mode, the static transfer switch shall connect clean filtered power to the load. The primary ac line shall be monitored, and the load shall be transferred to the inverter if the voltage drops below 85 percent. During on-line mode operation, any inverter problem shall cause an instantaneous transfer to the bypass mode.

2-5. MAINTENANCE BYPASS SWITCH. A maintenance bypass switch shall be provided so maintenance can be performed on the UPS without disrupting control system operation. The bypass switch shall be independent of the UPS electronics. The bypass switch shall be external to the UPS.

2-6. OUTPUT RECEPTACLE PANEL. An output receptacle panel with a variety of NEMA 5, 6, L5, and/or L6 receptacles shall be furnished on the rear of the UPS and connected to the distribution panel furnished under the Electrical section. The System Supplier shall coordinate the size, number, and type of the receptacles with the equipment as indicated on the Drawings.

2-7. CONTROL, INDICATION AND ALARM. Controls, indicators and alarms shall be provided as a part of the UPS. Control buttons and LED indicators shall be provided on the UPS panel and shall be permanently labeled.

2-7.01. Controls. A dc battery circuit breaker, a mode selector switch, and system "ON" and "OFF" buttons shall be provided.

2-7.02. Indication. A digital display for selection and indication of input, output, and battery voltages shall be provided.

LED indicators for inverter ready, frequency, battery voltage, overload, over temperature, and impending shutdown conditions shall be provided.

LED indicators for bypass ready, bypass mode, and on-line mode shall be provided.

2-7.03. Remote Alarms. The UPS shall have the following provisions for remote alarms.

2-7.03.01. General Alarm. For units 5 kW and larger, a common, isolated, dry, alarm contact rated 3 amperes at 120 volts ac shall be provided with the UPS for indication of general alarm. The contact shall close under any UPS fault condition.

2-7.03.02. Power Failure. For units 5 kW and larger, an isolated, dry, alarm contact rated 3 amperes at 120 volts ac shall be provided with the UPS for remote indication of power failure. The contact shall open upon loss of commercial power to the UPS. For units smaller than 5 kW, a relay shall be provided and connected across the incoming power as the means of providing a contact for indication of a power failure condition.

PART 3 - EXECUTION

3-1. INSTALLATION REQUIREMENTS. Installation requirements are specified in the Instrumentation and Control System section.

3-2. OWNER TRAINING. System Supplier shall provide a qualified representative at the jobsite to train Owner's personnel in operating, maintaining, and repairing the equipment. The training shall be in accordance with the Demonstration and Training section.

End of Section

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Section 40 71 00

FLOW INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. The Flow Instrument Section covers the furnishing of flow instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Design-Builder.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

Where possible, each instrument shall be factory wet flow calibrated to the full-scale flow range of the sensors or calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration and configuration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device requirements. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated on the Drawings or in the Instrument Device Schedule. The interconnecting cable shall be provided in the length necessary for installation. Splices shall not be allowed in the installed cable.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. As a minimum, an appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. FLOW INSTRUMENTATION.

2-2.01. Differential Pressure Flow Transmitters. Not used.

2-2.02. Magnetic Flowmeters, Signal Converters, and Accessories.

2-2.02.01. Magnetic Flowmeter. The magnetic flowmeter shall be a completely obstructionless, in-line flowmeter with no constrictions in the flow of fluid through the meter. The meter shall consist of a metallic tube with flanged ends and with grounding rings. Flange diameter and bolt drilling pattern shall comply with ANSI/ASME B16.5 for line sizes from one-half inch to 24 inches or AWWA C207 for line sizes larger than 24 inches. Flange class ratings and meter maximum pressure ratings shall be compatible with the adjoining piping. Flangeless wafer insert style meters may be used for pipe sizes up to 6 inches, where compatible with adjacent piping flanges. Self-cleaning electrodes shall be provided for all meters used for sludge metering. Electrode and liner materials shall be fully compatible with the process fluid as approved by the Design-Builder and shall comply with the requirements specified in the Instrument Device Schedule. Each meter shall be factory wet flow calibrated to the sensors full flow capacity, at a facility, which is traceable to NIST or other standard acceptable to Engineer, and a copy of the calibration, report shall be submitted as part of the operation and maintenance manual submittal.

The meter shall be capable of standing empty for extended periods of time without damage to any components.

The meter housing shall be of a splash-proof and drip-proof design, unless indicated on the Drawings or in the Instrument Device Schedule to be submersible. Where required to be submersible, the meter housing shall withstand submergence in 30 feet of water for 48 hours without damage.

Where indicated on the Drawings or in the Instrument Device Schedule, the meter shall be suitable for use in a Class I, Division 2, hazardous area.

Meters shall be manufactured by ABB, Siemens, Rosemount, Endress+Hauser, or equal.

2-2.02.02. Magnetic Flowmeter Signal Converters. Separately mounted, microprocessor-based signal converters shall be provided for the magnetic flowmeters. The signal converters shall include output damping, self-testing, built-in calibration capability, and an "empty pipe zero" contact input. The overall accuracy of the magnetic flowmeter transmitter and signal converter shall be ±1 percent of actual flow rate between 10% and 100% of full-scale. Repeatability shall be 0.25% of full scale. The meter manufacturer shall furnish the signal cable between the converter and the magnetic flowmeter. Signal cable shall be continuous and not spliced between the meter and the signal converter. The signal converter shall be housed in a corrosion-resistant, weatherproof NEMA Type 4X housing and shall be suitable for operation over an ambient temperature range of -30 to +140°F [-34 to +60°C], and relative humidity of 10 to 100 percent. The converter shall have an analog output of 4-20 mA dc. Where indicate on the

Drawings or in the Instrument Device Schedule, the converter shall have a pulse output designed to operate a remote seven-digit totalizer and scaled so that the totalizer will operate for 60 days at 100 percent flow without repeating. Scaling factors shall be field adjustable and shall be selected to provide a totalizer multiplier of a power of 10. Transmitters tagged on the Drawings or specified to be of the indicating type shall contain a local indicator with a minimum four-digit LCD type display, scaled to read in engineering units of flow.

Magnetic flowmeter systems shall provide zero flow stability by means of automatic zero adjustment of a DC excited metering circuit. Converters shall be capable of bi-directional flow measurement. Signal converters shall be of the same brand as the magnetic flowmeters.

Where indicated on the Drawings or in the Instrument Device Schedule, the signal converter shall have a non-reset seven-digit totalizer on the face of the enclosure.

The signal converter shall be diagnosed and recalibrated with the use of a hand-held communicator/calibrator device. One device shall be furnished for all converters provided by a single manufacturer.

2-2.03. Open Channel Ultrasonic Flow Meters. Not used.

2-2.04. Open Channel Admittance Probe Flowmeters. Not used.

2-2.05. Doppler Ultrasonic Flowmeters. Not used.

2-2.06. In-Line Type Ultrasonic Flowmeters (Single Path). Not used.

2-2.07. In-Line Type Ultrasonic Flowmeters (Multi-Path). Not used.

2-2.08. Averaging Pitot Type Flow Elements. Not used.

2-2.09. Thermal Dispersion Flowmeters. Each flowmeter shall utilize a thermal dispersion type, explosion-proof, and stainless steel or Hastelloy C sensing element installed in the process piping. The insertion length of the element shall be approximately one-half of the pipe diameter, and all mounting accessories shall be provided. The sensor shall have a 1 inch MNPT mounting connection, and an isolation valve and packing gland that allows insertion and removal while the piping is under pressure.

The electronic transmitter shall be remotely mounted within 30 feet of the sensor with interconnecting cable provided, as indicated on the Drawings or in the Instrument Device Schedule. The transmitter shall be of the ac-powered type. The unit shall be housed in a NEMA Type 4 enclosure or an explosion-proof enclosure suitable for hazardous locations, as indicated on the Drawings or in the

Instrument Device Schedule. The transmitter shall have a 4-20 mA dc analog output and a local indicator with a multi-line LCD display calibrated in engineering units of flow. The transmitter shall also display a totalized flow value and the temperature of the process fluid.

Accuracy of the flowmeter shall be 1 percent of full scale over a 20-to-1 operating range. The flowmeter shall be Fluid Components International insertion-type, or equal.

2-2.10. Propeller Flowmeters. The flowmeter body shall consist of a ductile iron or fabricated steel metering tube with flanged ends having a diameter and drilling conforming to ANSI/ASME B16.1, Class 125. The assembly shall be coated inside and outside with an epoxy or acrylic enamel. The assembly shall have an internal flow-straightening vane and a three-blade polypropylene propeller supported on long-life ceramic bearings. The propeller/meter head assembly shall be flanged to allow easy removal from the metering tube.

The flowmeter shall have a local register, which is magnetically coupled to a three bladed conical shaped propeller. The register head shall have a six-digit totalizer. Where tagged on the Drawings or specified to be the indicating type, the register shall have a rate-of-flow indicator.

The flowmeter accuracy shall be ±2 percent of actual rate over a 6-to-1 operating range. The flowmeter shall be Sensus "Model 102" or McCrometer/Water Specialties "Model ML04".

The converter/transmitter shall be McCrometer/Water Specialties “Model E7000” or “Model TR16”, or Sensus “ACT-PAK Model 100DN”.

2-2.11. Turbine Flowmeters. Not used.

2-2.12. Orifice Plates. Each orifice plate shall be an ANSI 150 lb. class, flange-mounted plate. Orifice plates shall be AISI Type 316 stainless steel, unless otherwise required by the process or as indicated on the Drawings or the Instrument Device Schedule. Orifice and flange size shall be as indicated in the Drawings or the Instrument Device Schedule. The orifice plate provided shall be designed to provide 35 psi of head loss across the device.

Each orifice plate shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or the Instrument Device Schedule. Each orifice plate shall be provided with a stamped stainless steel nameplate, attached to the plate. The nameplate shall contain all pertinent data regarding the plate.

2-2.13. Differential Pressure Flow Indicators. Not used.

2-2.14. Gas Service Rotameters. Rotameters shall be all metal variable area type utilizing an integral orifice plate and conical float. Float position shall be magnetically transmitted to an external indicating unit that linearizes and displays the flow in the engineering units indicated in the instrument data sheets. Flowmeter components shall be compatible with the measured process. Where the process is not defined, flowmeter wetted components shall be AISI Type 316 stainless steel. Flowmeter connections shall be 150 lb. ANSI flanges. Flowmeter assemblies shall be rated NEMA Type 4.

Where indicated in the Drawings or Instrument Device Schedule, flowmeters shall be provided with an adjustable, magnetic actuated switch. The switch shall actuate at the flow value listed in the Drawings or the Instrument Device Schedule. Switches shall be rated 5 amp [A] at 120 V ac.

Each rotameter shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or the Instrument Device Schedule.

Mounting and installation hardware shall be AISI Type 316L stainless steel. Gas service rotameters shall be ABB, Brooks Instrument, Krohne, or equal.

2-2.15. Liquid Service Rotameters. Rotameters shall be all metal variable area type utilizing an integral orifice plate and conical float. Float position shall be directly visible through a sealed glass or plexiglass viewing window. Flow scale shall be engraved on the viewing window. Flowmeter components shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, flowmeter wetted components shall be AISI Type 316 stainless steel. Float viewing window materials shall be compatible with the measured process, as indicated in the Instrument Data Sheets. Flowmeter connections shall be 150-lb ANSI flanges.

Where indicated in the Instrument Data Sheets or Instrument Device Schedule, flowmeters shall be provided with an adjustable, magnetic actuated switch. The switch shall actuate at the flow value listed in the Instrument Data Sheet. Switches shall be rated 5A at 120 volts ac.

Each rotameter shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Instrument Data Sheet or Instrument Device Schedule.

Mounting and installation hardware shall be AISI Type 316L stainless steel. Liquid service rotameters shall be ABB or equal.

2-2.16. Target-Type Flow Switches. Not used.

2-2.17. Coriolis Mass Flowmeters. Not used.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 40 72 00

PRESSURE AND LEVEL INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of pressure and level instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Design-Builder.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System section.

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings or Instrument Device Schedule.

2-1.02. Programming Device. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section.) The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. PRESSURE AND LEVEL INSTRUMENTATION.

2-2.01. Pressure and Pressure Sensing Level Transmitters. Transmitters shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. Process fluid shall be isolated from the sensing elements by AISI Type 316 stainless steel, Hastelloy-C, ceramic, or

cobalt-chromium-nickel alloy diaphragms, and the transducer may use a silicone oil fluid fill. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0° to 180°F [-17° to +82°C], and relative humidity of 5 to 100 percent. All parts shall be cadmium-plated carbon steel, stainless steel, or other corrosion-resistant materials. Transmitters shall have over-range protection to maximum line pressure. Accuracy of the transmitter shall be 0.1 percent of span, and transmitter output shall be 4-20 mA dc without the need for external load adjustment. Transmitters shall not be damaged by reverse polarity. Transmitters shall have an elevated or suppressed zero. For calibrated spans of less than 8 psig a differential pressure type transmitter with side vents shall be utilized.

Transmitters in absolute pressure applications shall be provided with a 316 stainless steel, three-valve manifold and a mounting bracket for calibration/testing and tapping point for pressure gauge. Manifolds shall have test ports on the instrument side of the valves and shall be Anderson-Greenwood "M4T". Transmitters in chemical applications shall include isolation diaphragm seals. Transmitters shall be provided with brackets for wall and pipe-stand mounting.

Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

Transmitters tagged on the Drawings or specified to be indicating type shall be furnished with LCD type digital indicators.

Transmitters will have a turndown ratio of 30:1, or more.

Transmitters shall be ABB “Model 264GS”, Siemens “SITRANS P”, Rosemount “Model 2051”, Endress+Hauser “Cerabar S”, or equal.

2-2.02. Premium Accuracy Pressure and Pressure Sensing Level Transmitters. Not used.

2-2.03. Differential Pressure Transmitters. Transmitters shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. Process fluid shall be isolated from the sensing elements by AISI Type 316 stainless steel, Hastelloy-C, ceramic, or cobalt-chromium-nickel alloy diaphragms, and the transducer may use a silicone oil fluid fill. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0° to 180°F [-17° to +82°C], with relative humidity of 5 to 100 percent. All parts shall be cadmium- plated carbon steel, stainless steel, or other corrosion-resistant materials. Vents shall be provided on the sides of the diaphragm housing body. Transmitters shall have positive over-range protection.

Accuracy of the transmitters shall be 0.1 percent of span, and the effect on accuracy caused by static pressure changes shall be negligible. Transmitter output shall be 4-20 mA dc without the need for external load adjustment. Transmitters shall not be damaged by reverse polarity. Each transmitter shall be provided with a 316 stainless steel, three-valve manifold and a mounting bracket for calibration/testing and tapping point for pressure gauge. Manifolds shall have test ports on the instrument side of the valves and shall be Anderson-Greenwood "M4T". Transmitters in chemical applications shall include isolation diaphragm seals.

Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

Transmitters tagged on the Drawings or specified to be the indicating type shall be furnished with LCD type digital indicators.

Transmitters will have a turndown ratio of 30:1.

Transmitters shall be ABB “Model 264DS”, Siemens “SITRANS P DS III”, Rosemount “Model 2051”, Endress+Hauser “Deltabar S Series”, or equal.

2-2.04. Premium Accuracy Differential Pressure Transmitters. Not used.

2-2.05. Flange-Mounted Pressure Sensing Level Transmitters. Level transmitters shall be of the differential pressure sensing type that connects to the process by a 3-inch [75 mm], ANSI/ASME B16.5, Class 150, flat faced, carbon steel mounting flange. Each transmitter shall have a 1/2-inch [12.7 mm] NPT low-pressure connection for the process or atmospheric reference. Where indicated on the Drawings or in the Instrument Device Schedule, the transmitter shall have a process flushing port connection on the process side of the mounting flange. The transmitter shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. Process fluid shall be isolated from the sensing elements by AISI Type 316 stainless steel, Hastelloy-C, ceramic, or cobalt-chromium-nickel alloy diaphragms, and the transducer may use a silicone oil fluid fill. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0° to 180°F [-17° to +82°C] and a relative humidity of 5 to 100 percent. All wetted parts shall be cadmium-plated carbon steel, stainless steel, or other corrosion-resistant materials. Transmitters shall have over-range protection to a maximum line pressure. Accuracy of the transmitter shall be 0.075 percent of span and the transmitter output shall be 4-20 mA dc without the need for external load adjustment. Transmitters shall not be damaged by reverse polarity. Transmitters shall have an elevated or suppressed zero.

Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

Transmitters tagged on the Drawings or specified to be the indicating type shall be furnished with LCD type digital indicators.

Transmitters shall be ABB “Model 264DC”, Endress+Hauser “Deltabar S Series”, Foxboro "Model IDP10 with Remote Seal", Rosemount “Model 2051LT”, or Siemens SITRANS P DS III.

2-2.06. Ultrasonic Level Transmitters. Each ultrasonic level transmitter shall be a microprocessor-based electronic unit consisting of a sensor assembly, a signal converter/transmitter, and an interconnecting cable. The sensor shall be encapsulated in a chemical and corrosion-resistant material such as Kynar or CPVC and shall be suitable for operation over a temperature range of -20° to +150°F [-28° to +66°C] and a relative humidity of 10 to 100 percent. The sensor shall be compatible with the process media being measured. Where indicated on the Drawings or in the Instrument Device Schedule, the sensor shall be an explosion-proof or intrinsically safe design suitable for use in all hazardous areas. Sensors mounted in areas subject to freezing shall be provided with special transducers or protected against icing by heaters. Sensors mounted in direct sunlight shall be provided with sunshades.

The supplier shall coordinate the sensor mounting requirements and furnish drawings complete with dimensions and elevations. General installation requirements are indicated on the Drawings.

The ultrasonic level transmitter shall have automatic compensation for changes in air temperature at the sensor location. If separate temperature sensing probes are provided, they shall be mounted with or adjacent to the ultrasonic sensor, as recommended by the manufacturer. The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 1/2 inch. The transmitter shall be designed to ignore momentary level spikes, false targets, or momentary loss-of-echo. A loss-of-echo condition shall be indicated on the transmitter unit and shall be available as an alarm contact output. The transmitter output shall be an isolated 4-20 mA dc signal linearly proportional to the measured level range, or where indicated on the Drawings or in the Instrument Device Schedule, shall be characterized to be proportional to the tank volume. Calibration parameters shall be entered through a keypad on the unit and shall be stored in nonvolatile EEPROM memory. Measurement resolution of the transmitted signal shall be 0.1 inch or less. Accuracy of the transmitted signal shall be ±0.25 percent of the level range greater than 3.3 feet. Measurement range of the transmitted signal shall be 0% through 100%.

Where indicated on the Drawings or in the Instrument Device Schedule, the transmitter shall be a differential level-sensing unit that accepts inputs from two ultrasonic level sensors. The transmitter output shall be proportional to the difference in level. The differential value shall be displayed on the unit. An adjustable alarm contact, actuated by differential level, shall be provided.

Where indicated on the Drawings or in the Instrument Device Schedule, the transmitter shall contain four independently adjustable level alarm contact outputs. Contacts shall be single-pole, single-throw, or double pole where indicated in the device schedule, rated not less than 5 amperes at 120 V ac.

A sufficient length of sensor-to-transmitter signal cable shall be furnished with the instrument to locate the sensor 25 to 200 feet from the signal converter.

For indoor installation, the signal converter electronics shall be housed in a NEMA Type 12 enclosure suitable for wall or pipe-stand mounting and for operating temperatures of +30° to +120°F [-1° to +49°C].

For outdoor installation, the signal converter electronics shall be housed in a weatherproof, corrosion-resistant NEMA Type 4 enclosure suitable for wall or pipestand mounting and for operating temperatures of -5° to +122°F [-20° to +50°C] and a relative humidity of 10 to 100 percent. A thermostatically controlled strip heater shall be provided in the signal converter enclosure.

The signal converter shall be of the ac-powered type. The ultrasonic level transmitter shall be ABB, Siemens “HydroRanger 200”, Rosemount, Endress+Hauser “Prosonic”, or equal

2-2.07. Admittance Probe Level Transmitters. Not used.

2-2.08. Submersible Pressure Sensing Level Transmitters. Not used.

2-2.09. Bubbler System Components. Not used.

2-2.10. Fixed-Mount Float Type Level Switches. Switches shall be of the floating ball type, with a nominal 5-1/2 inch diameter, coated stainless steel float ball that contains a sealed non-mercury switch assembly. The float shall be supported with a flexible synthetic rubber hinge fastened to an adjustable mounting bracket. The hinge shall also act as a housing for the lead wires from the alarm switch. The lead wire shall be a waterproof cable of such length that no splice or junction box is required in the wet well. Stainless steel mounting accessories shall be furnished. The switch contacts shall be single-pole-single-throw rated 1-amp [A] at 120 V ac. Switches shall be Magnetrol, Kari, ITT/Flygt or equal.

2-2.11. Weighted Float Type Level Switches. Each level switch shall consist of a single-pole, double-throw non-mercury switch, rated not less than 3 amp [A] ac, sealed and housed in a chemical-resistant polypropylene casing. The switch assembly shall be weighted and suspended on a waterproof, three-conductor, synthetic covered flexible cable with19 AWG conductors and of such length that no splice or junction box is required in the wet well. Switches shall be suitable for operation at up to 150 V ac within an ambient temperature range of 0 to 60°C. Switches shall be suitable for use in a sanitary wastewater wet well. Adjustable mounting hardware shall be provided for supporting each level switch. Switches shall be Magnetrol, Kari, ITT/Flygt or equal.

2-2.12. Adjustable Deadband Float Type Level Switches. Not used.

2-2.13. Electrode/Conductance Relay Level Switches. Not used.

2-2.14. Flange-Mounted Displacement Float Type Level Switches. Not used.

2-2.15. Flood Level Switches. The flood detecting level switches shall be float actuated and shall be suitable for wall bracket or sump mounting, as indicated on the Drawings or in the Instrument Device Schedule. The switch float mechanism shall actuate when the water level rises to 1 inch [25 mm] above the bottom of the housing. The switch contacts shall be hermetically sealed, rated for 0.1 amp [A] at 120 V ac, and shall be field changeable from normally open to normally closed. Flood switches shall be Contegra "Model FS 202".

2-2.16. Ultrasonic Level Switches. Not used.

2-2.17. Pressure Switches and Pressure Sensing Level Switches. Pressure and pressure sensing level switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches mounted inside panels shall have NEMA Type1 housings. All other switches shall have weatherproof housings. Switches shall be differential type where indicated in the Instrument Device Schedule. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or Viton and the connection port shall be stainless steel.

Panel-mounted and surface-mounted switches shall be provided with 1/4 inch NPT connections. All stem-mounted switches shall be provided with 1/2 inch NPT connections.

All pressure switches shall be ranged in psi [kPa] and all vacuum switches in inches of water. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp [A] at 120 V ac.

Each switch shall be provided with a threaded end, ball-type shutoff valve. Shutoff valve materials shall be compatible with the process fluid. Where the process is not specified, valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals. Multi-port valves shall have all unused ports plugged. Shutoff valve construction shall be as detailed in the Miscellaneous Instruments section.

Where indicated on the Drawings or in the Instrument Device Schedule, the switch shall be provided with a pressure snubber. Each snubber shall be of a size and pressure range compatible with the switch served. Snubbers shall be Ashcroft "Pulsation Dampers" or approved equal.

Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective switch. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless-steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the switch with the system under pressure. The lower housing shall be provided with a tapped and plugged 1/4 inch [6 mm] NPT flushing connection. Each diaphragm seal and the switch served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal.

Switches shall be manufactured by Ashcroft, or equal.

2-2.18. Radar Level Transmitters. Radar level transmitters shall be microprocessor-based electronic units each consisting of a transmitter with an external antenna cone. The antenna shall be suitable for operation over a temperature range of -20 to +150º F and a relative humidity of 10 to 100 percent. The antenna shall be compatible with the process media being measured and encapsulated with a material such as PTFE and suitable for flange mounting. The transmitter shall be capable of continuous monitoring of solids or liquids.

The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 0.5 inch. The transmitter shall be designed to ignore momentary level spikes, false targets, or momentary loss-of-echo. The transmitter shall be loop-powered with an isolated 4-20 mA dc output

signal linearly proportional to the measured level range. Accuracy of the transmitted signal shall be ±0.4 inches of the full range. Calibration parameters shall be entered through a keypad on the unit.

The transmitter shall be housed in a weatherproof, corrosion-resistant NEMA Type 4X enclosure directly coupled to the antenna.

The System Supplier shall provide an insulation kit (i.e., insulator-sleeved bolts and insulator washers), as required, to prevent corrosion due to dissimilar metals of the transmitter flange and the mounting pipe flange.

Contractor shall provide an adjustable transmitter mounting bracket to allow for an initial adjustment to the sensor placement with respect to the transmitter target. Bracket shall have set screws or a similar method for securing transmitter placement.

The radar level transmitter shall be Rosemount, ABB, Endress+Hauser, or equal.

2.2.19. Guided Wave Level Transmitters. Not used.

2-2.20. Field-Mount Pressure Gauges. Not used.

2-2.21. Annular Type Pressure Sensors. Pressure sensors shall be of the wafer type, designed to fit between standard Class 150 and Class 300 pipeline flanges. Flange material shall be the same as the surrounding pipeline. Sensor shall be flow through design with flexible elastomer sensing ring around the full circumference. The elastomer sensing ring shall be rigidly clamped between metal end cover flanges, and no part of the elastomeric sensing ring shall be exposed to the external face of the sensor. There shall be no dead ends or crevices, and flow passage shall make the sensor self-cleaning.

The pressure-sensing ring shall measure pressure for 360° around the full inside circumference of the pipeline. Flexible sensing ring shall have a cavity behind the ring filled with fluid to transfer pressure to the gauge. Sensing ring material shall be compatible with the process. Fill fluid shall be suitable for use with the process temperatures.

Annular pressure sensors shall be Red-Valve “Series 48” or equal.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 40 73 12

PRESSURE GAUGES

PART 1 - GENERAL

1-1. SCOPE. This section covers analog dial-type gauges and accessories to be furnished and installed at the locations indicated on the Drawings and as specified in the Gauge Schedule at the end of this section.

Gauges to be furnished by an equipment supplier, either with an item of equipment or as a component of an equipment package, shall be selected by the supplier in accordance with this specification unless covered in the other equipment specifications.

Gauge piping and fittings are covered in other sections.

1-2. GENERAL.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Governing Standard. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI/ASME B40.1.

1-2.03. Accuracy Grade. Unless otherwise specified, gauge accuracy shall be ANSI Grade 2A or better. Overall accuracy for diaphragm seal protected and liquid-filled gauges shall be ANSI Grade A or better.

1-3. SUBMITTALS. Complete drawings or catalog cuts, together with detailed specifications and data covering materials used, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. GAUGE CONSTRUCTION. Unless otherwise specified, gauges shall be indicating dial type, with C-type phosphor bronze Bourdon tube; stainless steel rotary geared movement; phenolic or polypropylene solid front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

The dial shall be 4-1/2 inches in diameter, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees nor more than 270 degrees of arc.

Unless otherwise indicated, pressure gauges shall measure in psig and vacuum gauges shall measure in inches Hg vacuum. All gauges shall have a suitable range to give mid-scale readings under normal conditions

Flush-mounted and surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections.

The units of measurement, range, and mounting configuration of each gauge shall be as indicated in the Gauge Schedule.

2-2. GAUGE ACCESSORIES.

2-2.01. Isolation Valves. Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Miscellaneous Ball Valves section.

2-2.02. Snubbers. Unless otherwise indicated in the Gauge Schedule, each pressure and compound pressure/vacuum gauge shall be provided with a pressure snubber. Each snubber shall be of internal or external design, fabricated of stainless steel, and of a size and pressure range compatible with the gauge served. Pressure snubbers shall be Operating and Maintenance Specialties "Ray Snubbers", Ashcroft "Pulsation Dampers", Weksler "Piston Type Pressure Snubbers", or Trerice "Pulsation Dampeners".

2-2.03. Gauge Isolators.

2-2.03.01. Pipe-mounted Diaphragm Seals. Pipe-mounted diaphragm seals shall be provided where indicated on the Drawings or in the Gauge Schedule. Diaphragm seals shall be thread-attached type with removable or cleanout AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and PVC, bronze, brass, carbon steel, or stainless steel lower housing. The diaphragm seal shall be of "continuous" design to safely contain the process fluid in the event of gauge breakage or removal with the system under pressure. The lower housing shall be provided with a tapped 1/4 inch NPT flushing connection and an MxF stainless steel needle valve.

Each diaphragm seal and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

2-2.03.02. In-line Diaphragm Seals. In-line, flow-through type diaphragm seals shall be provided where indicated on the Drawings or in the Gauge Schedule.

For in-line diaphragm seals in pipe less than 4 inches, ends shall be flanged, threaded, or welding type to fit the piping system in which the unit is installed. Flanges shall be flat faced, with ANSI/ASME B16.5, Class 150 diameter and drilling. Threaded ends shall conform to ANSI/ASME B1.20.1, NPT. Each diaphragm seal shall be provided with a removable or cleanout stainless steel diaphragm and shall be tapped for a 1/2 inch NPT gauge connection.

For in-line diaphragm seals in pipe 4 inches and larger, flange type gauge isolators shall be provided. Each unit shall consist of a carbon steel housing, carbon steel assembly flanges, and Buna-N flexible cylinder, and shall be filled with silicone oil. Each isolator shall be a Moyno "RKL Series W Pressure Sensor/Isolator", Ronningen-Petter "Iso-Ring", or Red Valve "Series 40 Flanged Sensor", suitable for installation between two flat faced ANSI/ASME B16.1, Class 125 cast iron pipe flanges, and tapped for a 1/2 inch NPT gauge connection.

Each diaphragm seal and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

PART 3 - EXECUTION

3-1. INSTALLATION. Gauges shall be installed at the locations indicated on the Drawings. Installation configurations shall conform to the requirements of the Gauge Installation Details.

All gauges, snubbers and diaphragm seals shall be installed in the vertical upright position. Threaded connections shall be assembled using Teflon thread tape or Teflon thread sealer, as specified in the Miscellaneous Piping and Accessories Installation section. Teflon thread sealer shall not be used for liquid oxygen or oxygen gas piping. All connections shall be free from leaks.

Lines shall be purged of trapped air at gauge locations prior to installation of the gauge or diaphragm seal.

End of Section

Schedule 40 73 12-S01
Pressure Gauges Schedule

Area	Designation	Service	Medium	Type	Units		Range	Mounting	Stem Location	P&ID Drawing No.	Furnished By	Installed By	Special Requirements
					*	kPa							
21	21-GRT-PG-1001	WWS	Grit							21-I-001	Packaged Headworks Supplier	Packaged Headworks Supplier	
21	21-GRT-PG-2001	WWS	Grit							21-I-002	Pacakged Headworks Supplier	Packaged Headworks Supplier	
23	23-ODC-PG-0001	NPW	Air							23-I-001	Packaged Odor Control System Supplier	Packaked Odor Control System Supplier	
23	23-ODC-PG-0002	NPW	Air							23-I-001	Packaged Odor Control System Supplier	Packaked Odor Control System Supplier	
23	23-ODC-PG-1001	PRW	Air							23-I-001	Packaged Odor Control System Supplier	Packaked Odor Control System Supplier	
23	23-ODC-PG-1002	NPW	Air							23-I-001	Packaged Odor Control System Supplier	Packaked Odor Control System Supplier	
31	31-SCM-PG-0002	WAS	Scum	Pressure	psi		0 - 60	stem	lower	31-I-003	Design-Builder	Design-Builder	9, 13
31	31-WAS-PG-0002	WAS	Sludge	Pressure	psi		0 - 60	stem	lower	31-I-003	Design-Builder	Design-Builder	9, 13
31	31-AER-PG-0101	AA	Air							31-I-004	Process Air Blower System Supplier	Process Air Blower System Supplier	
31	31-AER-PG-0201	AA	Air							31-I-004	Process Air Blower System Supplier	Process Air Blower System Supplier	
31	31-AER-PG-0302	AA	Air							31-I-004	Process Air Blower System Supplier	Process Air Blower System Supplier	
32	32-DRN-PG-0001	DRN	Wastewater							32-I-007	MBR System Supplier	Design-Builder	
32	32-DRN-PG-0002	DRN	Wastewater							32-I-007	MBR System Supplier	Design-Builder	
32	32-AIR-PG-0102	AS	Air							32-I-006	MBR System Supplier	MBR System Supplier	
32	32-AIR-PG-0202	AS	Air							32-I-006	MBR System Supplier	MBR System Supplier	
32	32-MEM-PG-1002	MFF	Wastewater							32-I-003	MBR System Supplier	Design-Builder	
32	32-MEM-PG-2002	MFF	Wastewater							32-I-004	MBR System Supplier	Design-Builder	
34	34-PRW-PG-0001	PRW	Water							34-I-001	Plant Recycled Water Pump Supplier	Plant Recycled Water Pump Supplier	
34	34-PRW-PG-0102	PRW	Water							34-I-001	Plant Recycled Water Pump Supplier	Plant Recycled Water Pump Supplier	
34	34-PRW-PG-0202	PRW	Water							34-I-001	Plant Recycled Water Pump Supplier	Plant Recycled Water Pump Supplier	
34	34-PRW-PG-0302	PRW	Water							34-I-001	Plant Recycled Water Pump Supplier	Plant Recycled Water Pump Supplier	
51	51-RO-PG-0101	ROF	Water							51-I-002	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-CIP-PG-0101	CIPR	Water							51-I-010	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-0102	ROF	Water							51-I-002	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-0103	FF	Water							51-I-011	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-0201	ROF	Water							51-I-002	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-CIP-PG-0201	CIPR	Water							51-I-010	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-0202	ROF	Water							51-I-002	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-0203	FF	Water							51-I-011	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-0301	ROF	Water							51-I-002	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-0302	ROF	Water							51-I-002	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-1001	ROF/ROC	Water							51-I-003	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-1004	ROC	Water							51-I-003	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-1006	ROP	Water							51-I-006	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-1007	ROC	Water							51-I-006	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-2001	ROF/ROC	Water							51-I-004	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-2004	ROC	Water							51-I-004	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-2006	ROP	Water							51-I-007	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-2007	ROC	Water							51-I-007	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-3001	ROP	Water							51-I-005	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	

Schedule 40 73 12-S01
Pressure Gauges Schedule

51	51-RO-PG-3004	ROC	Water							51-I-005	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-3006	ROP	Water							51-I-008	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
51	51-RO-PG-3007	ROC	Water							51-I-008	Reverse Osmosis System Supplier	Reverse Osmosis System Supplier	
61	61-CAL-PG-0001	UVE	Water							61-I-001	Calcite System Supplier	Calcite System Supplier	
61	61-CAL-PG-0002	UVE	Water							61-I-001	Calcite System Supplier	Calcite System Supplier	
61	61-CAL-PG-0003	UVE	Water							61-I-001	Calcite System Supplier	Calcite System Supplier	
61	61-CAL-PG-0004	UVE	Water							61-I-001	Calcite System Supplier	Calcite System Supplier	
61	61-CAL-PG-0005	IPR	Water							61-I-001	Calcite System Supplier	Calcite System Supplier	
63	63-TW-PG-0101	IPR	Water	Pressure	psi		0 - 60	stem	lower	63-I-001	Design-Builder	Design-Builder	9
63	63-TW-PG-0201	IPR	Water	Pressure	psi		0 - 60	stem	lower	63-I-001	Design-Builder	Design-Builder	9
63	63-TW-PG-0301	IPR	Water	Pressure	psi		0 - 60	stem	lower	63-I-001	Design-Builder	Design-Builder	9
64	64-TW-PG-0101	POW	Water	Pressure	psi		0 - 60	stem	lower	64-I-001	Design-Builder	Design-Builder	9
64	64-TW-PG-0201	POW	Water	Pressure	psi		0 - 60	stem	lower	64-I-001	Design-Builder	Design-Builder	9
64	64-TW-PG-0301	POW	Water	Pressure	psi		0 - 60	stem	lower	64-I-001	Design-Builder	Design-Builder	9
64	64-TW-PG-0401	POW	Water	Pressure	psi		0 - 60	stem	lower	64-I-001	Design-Builder	Design-Builder	9
71	71-AIR-PG-0101	AA	Air							71-I-003	Rotary PD Blower Supplier	Rotary PD Blower Supplier	
71	71-AIR-PG-0102	AA	Air							71-I-003	Rotary PD Blower Supplier	Rotary PD Blower Supplier	
71	71-AIR-PG-0201	AA	Air							71-I-003	Rotary PD Blower Supplier	Rotary PD Blower Supplier	
71	71-AIR-PG-0202	AA	Air							71-I-003	Rotary PD Blower Supplier	Rotary PD Blower Supplier	
72	72-DWT-PG-0102	AWS	Sludge							72-I-001	Dewatering System Supplier	Design-Builder	
72	72-DWT-PG-0202	AWS	Sludge							72-I-001	Dewatering System Supplier	Design-Builder	
73	73-FSW-PG-0003	FSW	Wastewater							73-I-001	Safe Filter Supplier	Design-Builder	
73	73-FSW-PG-0004	FBW	Wastewater							73-I-001	Safe Filter Supplier	Design-Builder	
90	90-NHS-PG-0001	NHS								90-I-004	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-ANTI-PG-0001	ANTI								90-I-005	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NPW-PG-0001	NPW								90-I-008	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-POLF-PG-0001	NPW								90-I-008	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-LAS-PG-0001	NHS								90-I-009	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NHS-PG-0002	NHS								90-I-004	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-ANTI-PG-0002	ANTI								90-I-005	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-LAS-PG-0002	NHS								90-I-009	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NHS-PG-0003	NHS								90-I-004	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NHS-PG-0004	NHS								90-I-004	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0101	NACL								90-I-001	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NAOH-PG-0101	NAOH								90-I-003	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-CA-PG-0101	CA								90-I-006	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-HSO4-PG-0101	SA								90-I-007	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0102	NACL								90-I-001	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NAOH-PG-0102	NAOH								90-I-003	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-CA-PG-0102	CA								90-I-006	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-HSO4-PG-0102	SA								90-I-007	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0201	NACL								90-I-001	Provided by Chemical System Supplier	Provided by Chemical System Supplier	

Schedule 40 73 12-S01
Pressure Gauges Schedule

90	90-NAOH-PG-0201	NAOH								90-I-003	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-CA-PG-0201	CA								90-I-006	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-HSO4-PG-0201	SA								90-I-007	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0202	NACL								90-I-001	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NAOH-PG-0202	NAOH								90-I-003	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-CA-PG-0202	CA								90-I-006	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-HSO4-PG-0202	SA								90-I-007	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0301	NACL								90-I-001	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NAOH-PG-0301	NAOH								90-I-003	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0302	NACL								90-I-001	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NAOH-PG-0302	NAOH								90-I-003	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0401	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0402	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0501	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0502	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0601	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0602	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0701	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	
90	90-NOCL-PG-0702	NACL								90-I-002	Provided by Chemical System Supplier	Provided by Chemical System Supplier	

Special requirements are as follows:

-1 ANSI Accuracy Grade _____ required.
-2 AISI Type 316 stainless steel Bourdon tube
-3 Bellows type with brass bellows and socket.
-4 Bellows type with AISI Type 316 stainless steel bellows and socket.
-5 Dial size shall be 6 inches [150 mm].
-6 Solid front case with pressure relief back required.
-7 Open front case with pressure relief required.
-8 Gauge shall be liquid filled.
-9 Gauge case shall be weatherproof.
-10 Overload stop required.
-11 Underload stop required.
-12 Snubber not required.
-13 Diaphragm seal required.
-14 Diaphragm seal shall be _____ instead of stainless steel.
-15 Diaphragm seal shall be in-line, flow-through type with _ threaded _ flanged _ welding _ ends.
-16 In-line, flow-through, flange type isolator required.
-17 Freeze protection required.
-18 Gauge piping shall be _____; fittings shall be _____.

*Units

1. inches of H2O
2. psi
3. inches of Hg vacuum

Section 40 74 00

TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of all temperature instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the drawings or the Instrument Device Schedule.

When multiple temperature instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in Instrumentation and Control System section.

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. TEMPERATURE INSTRUMENTS.

2-2.01. Resistance Temperature Detectors. Each temperature detector shall be a nominal 100 ohm, three or four wire, hermetically sealed, platinum resistance element. The sensing element shall be enclosed in an AISI Type 316 stainless steel outer sheath. Accuracy shall be ± 1°F over the specified operating range.

Each temperature detector shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel. The approximate process insertion length of the thermowell shall be as indicated on the Drawings or in the Instrument Device Schedule. The temperature element shall be spring-loaded in the thermowell. Appropriate temperature head hardware shall be provided with the assembly.

2-2.02. Resistance Temperature Transmitters. Each transmitter shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. The transmitter shall be designed for a resistance temperature detector input and shall have a 4-20 mA dc output.

The transmitter shall be of the sensor lead wire compensated type with linearized output to provide an accuracy of ± 0.2 percent of temperature span. The transmitter shall be housed in a weatherproof enclosure designed for mounting directly on or near the thermowell. Shielded lead wire shall be provided as needed between the transmitter and the temperature detector. Each transmitter shall be coordinated with the sensor and thermowell. Transmitters shall be manufactured by ABB, Siemens, Rosemount, Endress+Hauser, or equal.

Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

Transmitters tagged on the Drawings or specified to be the indicating type shall be furnished with LCD type digital indicators.

2-2.03. Temperature Switches. Temperature switches shall be ambient compensated, filled type, with integral sensor and thermowell. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual temperature. Switches shall be housed in EEMAC Type 4 enclosures. Switch wetted parts shall be compatible with the process fluid. Where the process fluid is not defined, the switch shall be provided with an AISI Type 316 stainless steel sensing element and an AISI Type 316 stainless steel thermowell.

All temperature switches shall be ranged in degrees Fahrenheit. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac.

Each switch shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless

steel. The approximate process insertion length of the thermowell shall be as indicated on the Drawings or in the Instrument Device Schedule.

Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation standards. All switches shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation.

Each switch shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or Instrument Device Schedule.

Unless otherwise indicated, mounting and installation hardware shall be AISI Type 316L stainless steel.

Temperature switches shall be Ashcroft, Allen-Bradley, or equal.

2-2.04. Temperature Gauges. Temperature gauges shall be of the indicating dial type, with a stainless steel bimetal thermometer and a stainless steel thermowell; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

Gauge dial shall be minimum 4-1/2 inch size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees or more than 270 degrees of arc.

Panel-mounted and surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections. Where indicated on the Drawings or the Instrument Device Schedule, stem mounted gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.

All temperature gauges shall measure in degrees Fahrenheit. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 1 percent of scale range.

Each gauge shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel.

Gauges shall be installed at the locations indicated on the Drawings, with installation conforming to the installation standards. All gauges shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at gauge locations prior to installation.

Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated on the Drawings or the Instrument Device Schedule.

Unless otherwise indicated, mounting and installation hardware shall be AISI Type 316L stainless steel.

Temperature gauges shall be Ashcroft “EL Series, Code 60”, or equal.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 40 75 00

PROCESS ANALYTICAL INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of all process analytical instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Design-Builder.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or in the Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in the Instrumentation and Control System Section.

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in as specified in the Instrumentation and Control System section.

1-4.01. Cleaning. Instruments indicated to be utilized in oxygen, ozone, or similar service shall be cleaned for oxygen service, labeled appropriately, and bagged or packaged as necessary to ensure the instrument will remain suitable for insertion in the process during installation. Any special mounting or installation requirements associated with such instruments shall be detailed on tags attached to the instrument.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Drawings and/or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. PROCESS LIQUID ANALYTICAL INSTRUMENTATION.

2-2.01. Low Range Turbidity Analyzers. Analyzers shall operate with a continuous flow of sample through the sample cell to drain. A Class 1 650 nm laser light source shall be passed through the sample and the amount of light scattered by the turbidity particles shall be measured. The analyzer shall utilize an US EPA approved method of turbidity analysis.

Sample flow rate shall be approximately 0.2 gpm. The sample cell shall be constructed of all corrosion-resistant materials and shall have an integral bubble trap. Accessories shall be provided to allow for a field calibration check of the analyzer. The secondary calibration standard shall be an optical glass calibration cube that has a known NTU value. One secondary calibration device shall be provided for each four analyzers. A one-year supply of consumables, including a primary standard formazin calibration kit, shall be provided with each analyzer.

The analyzer shall have a master indicator mounted near the sample cell and connected to the sample cell with a special cable. The unit shall have an auto-ranging three or four-digit display that indicates turbidity within a range of 0.001 to 100 nephelometric turbidity units (NTU). The analyzer accuracy shall be a maximum of 2% of NTU reading. The analyzer repeatability shall be a maximum of 1% of NTU reading. The master indicator shall be housed in a NEMA Type 12 moisture-resistant enclosure and shall be of the ac-powered type.

The master indicator shall have a linear 4-20 mA dc output signal that corresponds to a pre-selected turbidity range (typically 0 to 1 NTU). Each turbidity sensor shall be provided with an automatic cleaning module.

Turbidity analyzers shall be Hach Company TU5300 with SC200 controller or equal.

2-2.02. Surface Scatter Turbidity Analyzers. Analyzers shall operate with a continuous sample flow of approximately 0.3 gpm [0.01 L/s] through the analyzer to drain. The analyzer shall utilize a light beam that is focused on the liquid surface of the sample at an acute angle. The suspended particles in the sample will scatter the light, and a photocell mounted above the liquid surface shall detect the reflected light. The light and photocell sensor shall not come in contact with the sample liquid. The analyzer shall have an auto-ranging four-digit display that can indicate from 0.01 to 9999 NTU. The analyzer accuracy shall be a maximum of 2% of NTU reading. The analyzer repeatability shall be a maximum of 1% of NTU reading. The analyzer shall be housed in a NEMA Type 4X enclosure and shall be suitable for operation in an ambient temperature range of 0 to 40°C. The analyzer shall be of the ac powered type.

The analyzer shall have an essentially linear 4-20 mA dc output signal that corresponds to a pre-selected turbidity range.

Alarm points shall be conveniently set on the front of the analyzer. Alarm conditions shall be locally indicated on the face of the analyzer unit.

The turbidity analyzer shall be Hach Chemical Company "Surface Scatter 7" with SC200 controller or equal.

A bubble trap shall be provided on the sample inlet line to the analyzer. The bubble trap shall be of corrosion-resistant PVC construction and shall be specifically designed for use with the above analyzer.

2-2.03. pH and ORP Analyzers. The pH or ORP sensor and analyzer/transmitter shall be products of the same manufacturer. The cable between the sensor and the transmitter shall be provided by the manufacturer. The sensor shall consist of a Kynar, PVC, polypropylene, or other chemical-resistant electrode housing containing a glass pH electrode and a fouling-resistant reference electrode, or gold/platinum ORP electrodes. The pH reference electrode shall be self-contained and shall not require an external electrolyte reservoir. The sensor shall have automatic temperature compensation and shall be the flow-through type unless indicated on the Drawings or in the Instrument Device Schedule to be submersion type.

Flow-through type sensors, shall have 3/4 or 1 inch NPT process connections and shall be suitable for a working pressure of 1 to 100 psig at 140°F [60°C], with a sample flow rate of 0.5 gpm [0.03 L/s].

Submersion-type sensors, shall be suitable for submersion in 30 feet of water at temperatures of 32 to 140°F [0 to 60°C]. A protection shroud shall be provided to protect the electrode. The cable and cable entrance to the sensor shall be suitable for submersible applications.

Each pH sensor assembly shall be provided with a maintenance kit that shall include a spare pH electrode, a spare reference electrode, and other spare parts as recommended by the manufacturer.

The transmitter shall be enclosed in a cast aluminum or fiberglass reinforced plastic NEMA Type 4 housing. The transmitter shall be microprocessor based, with integral diagnostics, and with non-volatile memory. The transmitter shall be suitable for ambient temperatures of -30 to +60°C and a relative humidity of 0 to 100 percent. The transmitter shall have an isolated 4-20 mA dc output linearly proportional to the measured range, with an accuracy of ± 0.5 percent of reading. The analyzer repeatability shall be a maximum of 0.2% of reading. The transmitter shall have a 32-character alphanumeric multiline LCD display that is menu driven. Transmitter range shall be as indicated. The transmitter shall have automatic temperature compensation over a range of 0 to 50°C. The transmitter shall be of the ac-powered type. The transmitter shall be supplied with an appropriate length of signal cable for connecting the transmitter to the sensor.

The pH and ORP analyzers shall be manufactured by Hach Chemical Company with a SC200 controller or equal.

2-2.04. Dissolved Oxygen Analyzers. An optical type dissolve oxygen analyzer shall be provided. The principle of operation shall be based on the time measured from excitation of a luminescent material by a light source to the time light is emitted by the material. The luminescent material shall be mounted to an oxygen permeable replaceable cap fitted over the end of the probe. The probe shall be submersible and supplied with 30 ft of cable or a length of cable as otherwise indicate in the Instrument Device Schedule. The probe shall be provided with an automatic air blast cleaning system, complete with all required accessories and a compressor system contained in NEMA 4X enclosure. The compressor motor shall be 120-volt, single phase.

The transmitter shall be enclosed in a NEMA Type 4X enclosure with mounting brackets for surface or pipe mounting. The transmitter shall be of the ac-powered type. The transmitter shall have a local LCD display calibrated to read 0 to 20 ppm [mg/L] and shall have a corresponding 4-20 mA dc output signal capable of driving a 0 to 600 ohm external load. The transmitter and probe shall be furnished with all mounting hardware. The probe shall be the Hach Chemical Company LDO Model 2 probe with SC200 controller.

A membrane type analyzer shall be provided, having a galvanic or polarographic type (Ross or Clark principle) dissolved oxygen sensor. The sensor shall include a field replaceable cartridge assembly with pre-installed membrane, electrolyte, and electrodes that is disposable. The electrode chamber shall be isolated from the process by an oxygen-permeable (liquid-impermeable) membrane. A one-year supply of replacement membranes and electrolyte shall be provided. The sensor probe assembly shall be immersion type, with integral automatic temperature compensation over a range of 0 to 122°F. The sensor shall be insensitive to varying hydraulic heads up to a depth of 100 ft. The sensor shall be provided with an automatic air blast cleaning system, with compressor system contained in NEMA 4X enclosure. The compressor motor shall be 120-volt, single phase.

The dissolved oxygen transmitter shall be of the microprocessor type, with non-volatile memory, and built in diagnostics. The transmitter shall display the reading on an integral indicator and shall transmit an isolated 4-20 mA dc signal proportional to the amount of dissolved oxygen. The transmitter shall be of the ac-powered type. The transmitter shall be housed in a NEMA Type 4X enclosure and shall be suitable for surface or pipe mounting. The ambient temperature rating shall be -4°F [-20°C] to 140°F [60°C], with integral heater.

The dissolved oxygen analyzer shall be manufactured by Hach Chemical Company with a SC200 controller or equal.

2-2.05. Streaming Current Analyzers. Not used.

2-2.06. Suspended Solids Analyzers. Analyzers shall utilize a light beam that is focused on the liquid surface of the sample at an acute angle. The suspended particles in the sample will scatter the light and a photocell mounted above the liquid surface shall detect the reflected light. The light and photocell sensor shall not come in direct contact with the sample liquid. The analyzer shall have an auto-ranging display that indicates from 0.01 to 50,000 mg/l. The analyzer transmitter shall be housed in a NEMA Type 12 enclosure and shall be suitable for operation in an ambient temperature range of 0 to 104°F [40°C]. The analyzer transmitter shall be of the ac-powered type.

The analyzer shall have an essentially linear 4-20 mA dc output signal that corresponds to a pre-selected suspended solids range. The analyzer shall have adjustable high and low alarm contacts rated 24 V dc. Alarm points shall be conveniently set from the front of the analyzer. Alarm conditions shall be locally indicated on the face of the analyzer unit.

The suspended solids analyzer shall be Hach Chemical Company SOLITAX with SC200 controller or equal.

2-2.07. Particle Counters. Not used.

2-2.08. Chlorine Residual Analyzers. Chlorine residual analyzers shall be the amperometric, colorimetric, or gas stripping type and shall be provided with all required appurtenances shall be provided. For each type of analyzer supplied, a chlorine analyzer cleaning kit shall be provided. A one-year supply of all consumables shall be provided along with the cleaning kit. Chlorine analyzers shall measure the total or free chlorine residual in a continuous flow sample as indicated on the Drawings or in the Instrument Device Schedule.

2-2.08.01. Sample Conditioning Panel. A sample conditioning panel shall be furnished and installed upstream of each chlorine residual analyzer as indicated on the Drawings.

Each sample conditioning panel shall be provided with an enclosure with a mini programmable logic controller (PLC) or timer for automatic sequential solenoid valve control. The PLC program or timer shall open the two-way solenoid flush valve for an adjustable time (5 minutes initially) to provide a high volume flow rate through the strainer. After an adjustable time duration (3.5 minutes initially) during the high volume flow rate, the three-way solenoid valve shall be energized for an adjustable time duration (1.5 minutes initially) to flush the analyzer sample control needle valve. When the flush valve and needle valve timers have expired, both solenoid flush valves shall close and return the analyzer sampling to normal.

Each strainer shall be transparent PVC bodied Y-pattern with 30-mesh screen, Viton O-ring seals, and socket ends. The blowoff from the strainer shall be equipped with the minimum 1/4" inch threaded connection and ball valve for bypassing excess sample flow to drain and for adjusting the pressure in the sample flow to the analyzer. The strainer shall be an Asahi/America Sediment Strainer or approved equal.

Solenoid valves type and construction shall be as follows:

Service	Water
Type	2-Way and 3-Way, pilot operated
Body/Bonnet	Brass or bronze
Trim	
Seals	Buna-N or Teflon
Disc	Buna-N or Teflon
Stem	Manufacturer's standard
Bonnet Gasket	Manufacturer's standard
Spring	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	32 to 104°F
Valve Operator	Integral
Manufacturers	ASCO "8210 Series" 2-Way and "8300 Series" 3-Way

Solenoid valves shall have packless construction without packing box or sliding seal.

Solenoid coils for ac service shall be encapsulated, Class F, for continuous duty at rated voltage ± 10 percent and 40°C ambient, in a NEMA Type 4 enclosure with a conduit knockout.

2-2.08.02. Amperometric Chlorine Residual Analyzers and Titrator. Amperometric chlorine residual analyzers shall be furnished to measure the total or free chlorine residual in a continuous flow sample.

The analyzers shall be of the amperometric or amperometric/polarographic type, with automatic sample temperature compensator, sample flow control, and self-cleaning electrode assembly for operation over an adjustable range between 0 to

50 or 0 to 20 mg/L of chlorine. Each analyzer shall consist of three electrodes which will generate electric current and constant potential for accurate readings. Each analyzer shall operate with the following conditions:

Chlorine range, mg/L of chlorine	0 to 50 or 0 to 20
Analyzer accuracy	Residual levels below 20 mg/L: ±2% of reading or 0.001 mg/L of chlorine, whichever is greater Residual levels below 60 mg/L: ±5% of reading or 0.002 mg/L of chlorine, whichever is greater
Analyzer repeatability	0.2% of reading
Minimum required detection limit, mg/L chlorine	0.001
Sample water flow	Capital Controls: 2.4 gph Wallace & Tiernan: 1-2 gpm (potable); 3 to 5 gpm (wastewater)
Sample water pressure, psi	Capital Controls: 5 to 10 Wallace & Tiernan: 0 to 5

Each analyzer shall be furnished with the following accessories:

Sample filter.

Integral indicator calibrated 0 to 50 mg/L of chlorine.

A 1-year supply of chemicals and expendable materials.

Drain and overflow hose to bell-up.

Each analyzer instrument shall include a transmitter having a minimum of one 4-20 mA dc signal output. The analyzer shall be equipped with a minimum of three programmable relays to signal alarms. The analyzer shall operate using a 120 VAC, 60 Hz, single phase power supply.

The analyzer and electronics shall be installed in a wall panel for mounting. The electronics shall be enclosed in a NEMA 4X cabinet for protection. The analyzer dimensions shall not exceed 19 inches tall by 22 inches wide by 11 inches deep.

One amperometric titrator for measuring total or free residual shall be furnished for calibration of the chlorine residual analyzers. The titrator shall be complete with sample container, titrator solution bottle, pipettes, instruction book, chemicals, and other items required for proper operation. The titrator shall operate using a 120-volt, 60 Hz, single phase power supply.

The analyzer shall be De Nora Water Technologies/Capital Controls “Series CL1000”, ATI Model “Q46H/79PR”, or Evoqua Water Technologies/Wallace & Tiernan “Micro/2000”. The titrator shall be De Nora Water Technologies/Capital Controls “Series 17T2000” or Evoqua Water Technologies/Wallace & Tiernan “Series A-790”, or equal.

2-2.08.03. Colorimetric Chlorine Residual Analyzers. Colorimetric chlorine residual analyzers shall be furnished to measure the total or free chlorine residual in a continuous flow sample.

The analyzers shall be of the colorimeteric type for operation over a range of 0 to 5 mg/L of chlorine. The assembly shall consist of a sample chamber where the sample and reagents shall be thoroughly mixed with a self-cleaning stir bar. Each analyzer shall use reagents to color the sample. Light shall then be passed though the sample and a detector will measure its intensity to obtain a residual reading. Each analyzer shall be factory calibrated for accurate measurements.

Each analyzer shall operate with the following conditions:

Chlorine range, mg/L of chlorine	0 to 5
Analyzer accuracy	±5% of reading or 0.035 mg/L of chlorine, whichever is greater
Analyzer repeatability	0.2% of reading
Minimum required detection limit, mg/L chlorine	0.035
Sample water flow, gph	3.1 to 8.0
Sample water pressure, psig	1 to 5

Each analyzer shall complete a sample analysis every 2 minutes and 30 seconds. The use of chemical indicator and buffer shall not exceed 475 milliliters each over 30 days.

Each analyzer shall be furnished with the following accessories:

Sample conditioning kit.

Instrument factory calibrated 0 to 5 mg/L chlorine.

A 30-day supply of chemicals and expendable materials.

Drain and overflow hose to bell-up.

Each sample conditioning kit shall be installed upstream of the analyzer and shall be able to accommodate pressures up to 70 psi. Each kit shall include the

required valves, filter, fittings, and tubing required for proper analyzer operating conditions.

Each analyzer instrument shall include a transmitter having a programmable 4-20 mA dc signal output. The analyzer shall be equipped with two selectable alarms. The choices of alarms shall include high/low sample concentration, analyzer system warning to indicate a not-critical instrument malfunction, and analyzer system alarm to sound during analyzer failure. The analyzer shall operate using a 115 VAC, 60 Hz power supply.

The analyzer shall be installed in an enclosure for wall mounting. The analyzer dimensions shall not exceed 17 inches tall by 13 inches wide by 7 inches deep.

One colorimetric verification kit for measuring total or free residual shall be furnished for calibration of the chlorine residual analyzers. The verification kit shall be complete with 3 – way valve, bottle cap, pressurization apparatus, calibration standards set, instruction book, chemicals, and other items required for proper operation.

The analyzer shall be Hach “CL17 Chlorine Analyzer” or equal. The verification kit shall be Hach “CL17 CAL/Verification Kit”.

2-2.08.04. Gas Stripped Chlorine Residual Analyzers. Gas stripping chlorine residual analyzers shall be furnished to measure the total or free chlorine residual in a continuous flow sample.

The analyzers shall be of the gas stripping type for operation over a range of 0 to 2 or 0 to 20 ppm of chlorine. The assembly shall use peristaltic pumps to mix the sample, buffer reagents, and potassium iodide reagent. The mixture shall then enter the stripping chamber where it will mix with air from the internal air diaphragm pump. The air/iodine shall proceed to the sensing chamber where the membrane iodine sensor shall measure the iodine concentration and determine the chlorine residual.

Each peristaltic pump shall have quick-load pump heads for simple tube changing procedures. Tubes shall be constructed of materials compatible to the pumped chemical and shall be sized as recommended by the manufacturer. The airflow diaphragm pump shall be internal to the analyzer. A precision metering valve shall control the flow rate and an internal rotameter shall be used for flow indication. The airflow diaphragm pump, precision metering valve, and rotameter shall be properly sized for the analyzer as recommended by the manufacturer.

Each analyzer shall operate with the following conditions:

Chlorine range, mg/L of chlorine	0 to 2 or 0 to 20
Analyzer accuracy	±0.5% of reading or ±0.02 ppm of chlorine
Analyzer repeatability	0.2% of reading
Minimum detection limit, ppm chlorine	0.003
Sample water flow, gph	10 to 20
Sample water pressure, psig	Nominal 1 PSIG

Each analyzer shall complete a sample analysis every 30 seconds.

Each analyzer shall be furnished with the following accessories:

Integral indicator calibrated 0 to 2 or 0 to 20 ppm.

A 1-year supply of chemicals and expendable materials.

Drain and overflow hose to bell-up.

Each analyzer instrument shall include a programmable 4-20 mA dc analog output signal. The analyzer shall be equipped with two alarms. The analyzer shall operate using a 120 VAC, 60 Hz power supply.

The analyzer shall be installed in an enclosure for wall or panel mounting. The analyzer dimensions shall not exceed 33 inches tall by 18 inches wide.

One amperometric titrator for measuring total or free residual shall be furnished for calibration of the chlorine residual analyzers. The titrator shall be complete with sample container, titrating solution bottle, pipettes, instruction book, chemicals, and other items required for proper operation. The titrator shall operate using a 120-volt, 60 Hz, single phase power supply.

The analyzer shall be Analytical Technology, Inc. (ATI) “Model A15/79”. The titrator shall be Capital Controls “Series 17T2000” or Wallace & Tiernan “Series A-790” or equal.

2-2.09. Dissolved Ozone Analyzers. Not used.

2-2.10. Nuclear Sludge Density Meters. Not used.

2-2.11. Conductivity Analyzers – Electrode Type. The conductivity sensor and analyzer/transmitter shall be products of the same manufacturer. The cable between the sensor and the transmitter shall be provided by the manufacturer. The sensor electrodes shall be titanium or 316 SST. The sensor shall have automatic temperature compensation.

Submersion type sensors shall be suitable for submersion in 30 feet of water at temperatures 32 to 140ºF. A protection shroud shall be provided to protect the electrode. The cable and cable entrance to the sensor shall be suitable for submersible applications.

Each conductivity sensor assembly shall be provided with a maintenance kit that shall include a spare conductivity electrode and other spare parts as recommended by the manufacturer. Accessories shall be provided to allow for a field calibration check of the analyzer.

The transmitter shall be enclosed in a cast aluminum or fiberglass reinforced plastic NEMA Type 4 housing. The transmitter shall be microprocessor based, with integral diagnostics, and with non-volatile memory. The transmitter shall be suitable for ambient temperatures of -22 to +140°F and a relative humidity of 0 to 100 percent. The transmitter shall have an isolated 4-20 mA dc output linearly proportional to the measured range, with an accuracy of ± 3 percent of reading. Repeatability shall be 0.2% of reading. The transmitter shall have a multiline LCD display that is menu driven. Transmitter range shall be as indicated. The transmitter shall be of the dc-powered type. The transmitter shall be supplied with an appropriate length of signal cable for connecting the transmitter to the sensor.

The conductivity analyzer shall be manufactured by Hach or equal.

2-2.12. Conductivity Analyzers – Electrodeless Type. The instrument shall measure conductivity of the process by use of an inductive principle of measurement and employ a toroidal (electrodeless) conductivity sensor.

The toroidal conductivity sensor shall consist of a large bore sensor encapsulated in PEEK, polypropylene, PVDF, or Teflon suitable for applications containing high levels of suspended solids. The sensor shall be suitable for insertion or submersion service. The sensor shall measure conductivity from 50 μS/cm to at least 1000 mS/cm. The sensor shall have a threaded process connection suitable for end-of-pipe or flange mounting and it shall be furnished with an integral cable of sufficient length to provide an un-spliced connection to the analyzer. The sensor shall have an embedded RTD to sense process temperature for use by the analyzer.

The conductivity sensor shall be Hach “3700 Series” or equal.

The analyzer shall be of the same manufacturer as the sensor and it shall measure over the full range of the conductivity sensor furnished. The analyzer shall be housed in a NEMA Type 4X (IP65), flame-retardant enclosure suitable for panel, pipe, or wall mounting. All analyzer functions shall be accessible through a front panel membrane keyboard. Settings may be protected against

accidental or unauthorized changes by a user selectable security code. The analyzer display shall indicate the measured conductivity and process temperature values in engineering units, and it shall indicate fault conditions. Engineering units shall be selectable between mS/cm and solution percent concentration for conductivity and between degrees Fahrenheit and degrees Celsius for temperature. Displayed accuracy shall be ±3 percent of reading for conductivity. Repeatability shall be 0.2% of reading for conductivity.

The transmitter shall have an isolated 4-20 mA dc output linearly proportional to the measured range, with an accuracy of ± 0.5 percent of scale.

2-2.13. Total Organic Carbon Analyzers. The analyzer shall be a continuous monitoring system consisting of a flow through sensor and analyzer/transmitter designed to continuously measure the total organic carbon (TOC) of liquids and produce an output signal linearly proportional to the TOC. The measurement principle shall comply with Standard Methods 5310 C and US EPA 415.1, or US EPA 415.3.

The TOC analyzer shall have a range of 0 to 25 mg/L, accuracy ±2.0 percent of full scale, repeatability of ±2.0 percent of reading. Response time shall be between 4-8 minutes. Sample pressure maximum is 87 psig with a flow rate between 50-200 mL/min. The maximum sample temperature is 158ºF with a normal operating temperature of 50-104ºF.

TOC concentrations in the RO feed and RO permeate are the following:

RO Feed TOC: 7 – 15 mg/L

RO Permeate TOC <0.07 – 0.5 mg/L

For systems utilizing US EPA method 415.3, an inorganic carbon remover (ICR) shall be provided to reduce inorganic carbon levels.

The analyzer housing shall be a NEMA 4 enclosure equipped with stainless steel hardware for surface mounting. Connections shall be 1/4-inch flexible PVC tubing. The transmitter shall be provided with a multiline LCD display capable of indicating the sample TOC. Controls shall be provided on the front of the panel with menu-driven display for user-entered parameters and calibration. A minimum of one 4-20 mA dc output and two digital outputs shall be provided. The transmitter shall have a minimum of one alarm output. The analyzer shall be powered by 120 VAC, 60 Hz, single phase.

The analyzer shall be provided with a one-year supply of all consumable products required to operate.

The analyzer shall be Hach BioTector B3500, Hach BioTector B7000i or equal.

2-3. PROCESS GAS ANALYTICAL INSTRUMENTATION.

2-3.01. Gas Detector Systems. Gas detector systems shall be furnished complete with sensors, power supplies, alarm modules, enclosures, and appurtenant devices suitable for detecting gases as indicated on the Drawings or as listed in this section. Detector systems shall be located as indicated on the Drawings.

Gases to be detected and associated detector sensor ranges and nominal alarm setpoints shall be as follows:

Gas	Nominal Range	Nominal "Warning" and "Alarm" Values
Combustible Gas (methane)	0-100 percent LEL	10 percent/ 50 percent LEL
Hydrogen Sulfide (H_2S)	0-10 ppm or 0-50 ppm	0.5 ppm/1 ppm
Oxygen Deficiency (O_2)	0-10 percent or 0-25 percent	19.5/ percent 17 percent

Accuracy of each gas detector system shall be 2 percent of full scale, and zero drift shall not exceed 5 percent per year. Gas detector systems shall be suitable for an operating temperature range of 0 to 122°F [50°C].

Gas detector systems shall be MSA Ultima X Series, Scott Safety Freedom 5000 Series, Sierra Monitor Corporation, or equal.

2-3.01.01. Sensors. Sensors shall be of the remote mounted diffusion cell type contained in corrosion resistant weatherproof housings. Sensors shall be rated either intrinsically safe or explosion proof and shall be suitable for the environment in which they will be located. Sensors shall not require any addition of chemical reagents and shall require no routine maintenance other than calibration checks. Combustible gas sensors shall not be adversely affected by exposure to hydrogen sulfide gases. Minimum sensor life shall be 1 year. A sufficient length of cable shall be provided for connecting the sensor to the alarm module enclosure. The transmitter shall be provided with a serial output for instrument diagnostics and process monitoring.

2-3.01.02. Receiver-Alarm Modules. Each gas detector system shall be provided with a receiver-alarm module for each sensor. The receiver-alarm modules shall be housed in weatherproof NEMA 4X enclosures suitable for an operating temperature of -4°F [-20°C] to 122°F [50°C], with a relative humidity of 5 to 95 percent. Each alarm module shall have a separate, three-digit LED or LCD readout with units of the corresponding sensor engraved on the module face or included on the LCD readout. Each module shall have two independently

adjustable alarm points, one labeled "warning" and one labeled "alarm". Each alarm point, plus a module fail alarm point shall actuate separate relays with single-pole, double-throw contacts, rated 3 amps [A] at 120 V ac, and shall illuminate three alarm lights on the module face. Modules shall be of the ac-powered type and shall be designed with failsafe circuitry, so the alarm contacts fail in the alarm condition upon power or sensor failure. Each alarm module shall actuate a local alarm horn or buzzer at the unit, which can be silenced with a button on the unit. Each alarm module shall have an isolated 4-20 mA dc output signal representing the calibrated range of the detector system and capable of driving an external 250-ohm load.

Additional relays shall be provided in the module enclosure as needed to provide additional contacts indicated on the electrical schematic Drawings.

2-3.01.03. Gas Detector Calibration Kit. A calibration kit shall be provided for use in field calibration of each gas detector. The calibration kit shall contain all necessary fittings, calibration gases, and hoses required for not less than 12 field calibration checks of each gas detector, after final acceptance of the system.

2-3.01.04. Spare Sensors. One spare sensor shall be provided for each sensor in the gas detector system. Spare sensors shall be provided in addition to any replacement sensors required during the warranty period, even if the warranty period exceeds the normal expected life of the sensor. Delivery schedule for the spare sensors shall be as recommended by the manufacturer and as coordinated with Owner.

2-3.02. Low Concentration Ozone Analyzers. Not used.

2-3.03. High Concentration Ozone Analyzers. Not used.

2-3.04. Oxygen Purity Analyzers. Not used.

2-3.05. Dewpoint Analyzers. Not used.

2-3.06. Hydrocarbon Analyzers. Not used.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall

contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 40 78 00

PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL.

1-1. SCOPE. The Panel Mounted Instruments section covers the furnishing of all panel mounted instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1-2. DESIGN CRITERIA. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. For "smart" devices, calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs describe minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01 Programming Device. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training stipulations. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.02 Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a laptop computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device need not be furnished.

2-2. PANEL FRONT MOUNTED DEVICES.

2-2.01. Annunciators. Not used.

2-2.02. Totalizers. Not used.

2-2.03. Digital Panel Indicators. Digital indicators shall be designed for semi-flush mounting in a panel. The indicator shall be a 3-1/2 digit LED, LCD, or gas discharge type display, with digits at least 0.5 inch high. The indicator shall be easily read at a distance of 10 feet [3 m] in varying control room lighting environments. Operating temperature range shall be 32°F [0°C] to 140°F [60°C]. Accuracy shall be ±0.1 percent. The indicator shall be scaled in engineering units, with the units engraved on the display face or on the associated nameplate. The indicator shall have a selectable decimal point and shall provide over-range indication. Digital indicators shall be manufactured by Schneider Electric/Eurotherm/Action Instruments, Omega Engineering, Inc./Newport Electronics, Precision Digital Corporation, or Red Lion Controls.

2-2.04. Electronic Bar Graph Indicators. Indicators shall be of the single vertical bar graph type, with all solid-state electronic circuitry and no moving parts. The bar graph shall consist of a dot matrix, gas-discharge, or LED bar type display in combination with a digital display. Average display life shall be at least 10 years. Display length shall be 4 inches. The indicator shall have an electrical zero adjustment. Accuracy shall be ±1 percent of span. Scales shall be as indicated on the Drawings or the Instrument Device Schedule. The use of a dual display indicator for displaying two related signals will be considered. However, Design-

Builder reserves the right to require individual indicators where determined to be appropriate. Indicators shall have isolated, non-grounded inputs. If input is grounded, a signal isolator shall be provided between the meter and the rest of the signal. Bar graph indicators shall be OTEK Corporation or Weschler Instruments.

2-2.05. Edgewise Panel Indicators. Edgewise indicators, designed for panel mounting, shall have nominal 2 x 6 inch [50 x 150 mm] face dimensions. Indicators shall have nominal 4.5 inch [114 mm] scale length, and the indicator accuracy shall be ±2 percent of full scale. Major scale divisions shall be equally spaced and shall be in whole integers. Scale ranges shall be as indicated on the Drawings or the Instrument Device Schedule. Scale units (ft, mgd, etc.) shall be engraved on the scale face or on the indicator nameplate. The indicators shall be Weschler Instruments "Type 252 or equal."

2-2.06. Manual Loading Stations. Not used.

2-2.07. Ratio Stations. Not used.

2-2.08. 1/4 DIN Single-Loop Control Stations. Not used.

2-2.9. 1/4 DIN Manual/Auto Backup Stations. Not used.

2-2.10. Large Case Recorders. Not used.

2-2.11. Strip Chart Recorders. Not used.

2-2.12. Panel-Mounted Pressure Gauges. Gauge sizes and scale ranges for pressure, vacuum, or compound gauges shall be as indicated on the Drawings or the Instrument Device Schedule. Gauges shall be of the differential pressure type where indicated. Gauge scales shall have at least 5 major and 50 minor divisions. Major divisions shall be equally spaced and shall be in whole integers. Scale units (inches, psi, and feet) shall be engraved on the scale face. Each gauge shall be provided with a ball-type shutoff valve.

All gauges with spans of 10 psi or less shall have AISI Type 316 stainless steel bellows and connections. All process gauges with spans greater than 10 psi shall have an AISI Type 316 stainless steel Bourdon tube and connections.

The manufacturer's standard ranges will be considered if approximately equal to the specified range. However, Design-Builder reserves the right to require special scales and calibration if the manufacturer's standard is not acceptable. Gauges shall have clear acrylic or shatterproof glass windows, adjustable pointers, stainless steel geared movements, and shock-resistant cases. Pointer travel shall span not less than 200 degrees or more than 270 degrees. Gauge accuracy shall be nominal 1 percent of span, corresponding to ANSI B40.1,

Accuracy Grade A. Gauges shall be manufactured by Ashcroft, Ametek/U.S. Gauge, or Weksler.

2-2.13. Digital Panel Clocks. Not used.

2-2.14. Switches, Lights, and Push Buttons.

2-2.14.01. Selector Switches. Selector switches shall be 30.5-mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 V ac. Contact configuration shall be as indicated on the Drawings or for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Micro Switch “Type PT”, Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2-2.14.02. Indicating Lights. Indicating lights shall be 30.5-mm, heavy-duty, oil-tight type, with full voltage LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lights shall be push-to-test type. Indicating lights shall be Micro Switch “Type PT”, Eaton/Cutler Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2-2.14.03. Push Buttons. Push buttons shall be 30.5-mm, heavy-duty, oil-tight type. Legends shall be engraved on the push-button faceplate. Contacts shall be rated 10 amperes continuous at 120 V ac. Push buttons shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2-2.15. Alarm Horns. Horns shall be high-decibel, panel-mount, vibrating type designed for heavy-duty use. Horn volume shall be field-adjustable from 78 to 103 dB at 10 feet. Horns shall operate at 120 volts ac. Horns shall be weatherproof NEMA Type 4X. Horns which are panel front mounted and shall be supplied with gasket. These horns shall be Edwards Signals “870P Series.” Horns may also be supplied with a field mounted enclosure. These horns shall be Edwards Signals “876 series.”

2-3. PANEL INTERIOR MOUNTED DEVICES.

2-3.01. Integrators. Not used.

2-3.02. Power Supplies. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or shortcircuit protected. Output voltage regulation shall be by the instrumentation equipment supplied. Multiloop or multisystem power supplies will be acceptable

if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so either the primary or the backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation. Multiloop power supply connections shall be individually fused so a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and shall be located for easy access. Multiloop supply systems shall be oversized for an additional 10 percent future load. Failure of a multiloop supply shall be indicated on the respective instrument panel or enclosure.

Power supplies shall be Allen Bradley, Phoenix Contact, PULS, or equal.

2-3.03. Relays. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver cadmium oxide contacts rated 10 amperes at 120 V ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low-level signals. Relays used for computer input, alarm input, or indicating light service shall have contacts rated at least 3 amperes. Time delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of ±2 percent of setting. Latching and special purpose relays shall be for the specific application. Unless otherwise indicated, all relays shall have an integral pilot light that illuminates to indicate an energized condition. Relays shall be IDEC "Series RR"; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series 219, 246".

2-3.04. Intrinsically Safe Relays. Relays shall be solid-state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe use in hazardous areas. Relays shall be located in non-hazardous areas. Relays shall be manufactured by GEMS, Eaton/MTL, R.Stahl, Inc., or Turck.

2-3.05. Electronic Signal Booster/Isolators. Electronic signal boosters and isolators shall have all solid-state circuitry and complete electrical isolation between the power supply and the input and output signals. Accuracy shall be ±0.15 percent of span. Isolators shall be manufactured by Acromag, Moore Industries-International, Inc., or Phoenix Contact.

2-3.06. Electronic Signal Selectors. Not used.

2-3.07. Electronic Signal Summers. Not used.

2-3.08. Fixed Deadband Signal Monitors. Not used.

2-3.09. Adjustable Deadband Signal Monitors. Not used.

2-3.10. Strip Heaters. Electric strip heaters shall be provided as indicated on the Drawings, as specified, and for the application. Strip heaters shall be sized to prevent condensation within the enclosure and to maintain the equipment above its minimum operating temperature. Strip heaters shall be located to avoid overheating electronic hardware or producing large temperature fluctuations. Strip heaters shall be controlled by adjustable thermostats with adjustment ranges of 30° to 90°F [-1° to +32°C]. A circuit disconnect switch shall be provided within the enclosure.

2-3.11. Intrinsically Safe Barriers. Barriers shall be solid-state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe use in hazardous areas. Barriers shall be located in non-hazardous areas. Barriers shall be manufactured by MTL, R. Stahl, Inc., or Turck.

PART 3 – EXECUTION

3-1 FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 40 79 11

MISCELLANEOUS INSTRUMENTS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of all miscellaneous instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

When multiple miscellaneous instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1-2. DESIGN CRITERIA. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.

Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1-3. SUBMITTALS. Submittals shall be made as specified in Instrumentation and Control System section.

1-4. SHIPMENT, PROTECTION, AND STORAGE. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2-1. GENERAL. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2-1.01. Interconnecting Cable. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

2-1.02. Programming Device. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2-1.03. Configuration Software/Serial Interface. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2-2. MISCELLANEOUS INSTRUMENTS.

2-2.01. Field-Mounted Process Indicators. Not used.

2-2.02. Milliamp Calibrator. Not used.

2-2.03. Pressure Calibrator. Not used.

2-2.04. Multi-function Instrument Calibrator. The calibrator shall be completely portable and shall be capable of measuring and generating milliamperes, millivolts and volts. The calibrator shall have one 4-1/2 digit display capable of indicating either calibrator input or output. The display indication (output or input) shall be switch selectable. The input display shall be bipolar, complete with a minus (-) sign.

Inputs shall range from -50 to +50 volts; -100 to +100 mV; and -50 to +50 mA dc. Outputs ranges shall cover 0 to 110 mV, 0 to 11 volts and 0 to 22 mA dc. Input and output accuracy shall be ± 0.1 percent of full scale and shall be traceable to the National Institute of Standards and Technology. The calibrator shall be capable of simulating a two-wire transmitter operating from an external supply voltage of 12 to 65 V dc or driving an external load of 0 to 400 ohms at 20 mA dc from the calibrator's internal 24 V dc supply. The calibrator shall have input-output isolation and shall be protected against misconnection and overvoltage.

The calibrator shall be powered from a snap-in battery pack capable of operating the calibrator for 8 hours at 20 mA continuous output. The calibrator shall be supplied with two battery packs, a separate battery charger, a carrying case, an instruction manual, and test leads. The calibrator shall be Transmation "1091PLUS".

The calibrator shall be capable of measuring pressure in inches of water or psig. Accuracy of pressure measurement shall be 0.07 percent of full scale and shall be traceable to the National Institute of Standards and Technology. The pressure modules shall have over pressure relief that protects calibration and shall be compatible with nonconductive, noncorrosive, instrument-grade clean air or clean inert gas. Pressure ranges and modules shall be provided as follows:

Pressure Ranges

Dual Scale: 0-10 PSIG; 0-280" H_2O

Dual Scale: 0-33 PSIG; 0 to 830 inches H_2O

Single Scale: 0 to 100 psig

The calibrator shall be provided with fittings, connecting tubing and a portable air supply pump. The air supply pump shall be Transmation "P".

2-2.05. Manometer. Not used.

2-2.06. Proximity (Door) Switches. Proximity switches shall be magnetic proximity type, consisting of two sensors. One sensor shall be fixed to the door and the other to the door frame. The sensor mounted to the door shall have no electrical connections. Switches shall be provided with DPDT contacts rated 5 amperes at 120 V ac. All necessary mounting hardware shall be provided to allow both the sensors to be installed at the locations indicated on the Drawings.

2-2.07. Vibration Switches. Not used.

2-2.08. Instrument Shutoff Valves. Instrument shutoff valves shall be provided for instruments as indicated on the Drawings and as detailed in the specifications. The indicated shutoff valves shall be provided by System Supplier for all instruments furnished under the Panel Mounted Instruments section, Flow Instruments section, Pressure and Level Instruments section and Analytical Instruments section[ZKE1]. Shutoff valves shall be compatible with the measured process and shall be selected in accordance with the manufacturer's recommendations for the specified process. Unused ports of multi-port gauge valves shall be plugged. An instrument shutoff valve schedule shall be submitted indicating the quantity, material, size, and associated instrument. Permanent tagging of the instrument valves is not required. However, temporary hand-written tags or other means of identification shall be provided to ensure that the appropriate valve is installed for a given instrument.

Instrument shutoff valves shall be D/A Manufacturing, Anderson-Greenwood, or equal.

PART 3 - EXECUTION

3-1. FIELD SERVICES. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Section 41 12 13.36

SCREW CONVEYORS - DEWATERING

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of screw conveyors as indicated herein:

Conveyor designation.	Dewatering Conveyors
Number of conveyors.	3
Conveyor tag numbers.	DWT-COS-0001
	DWT-COS-0002
	DWT-COS-0003
Conveyor location.	Residuals Area

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations furnished by the equipment manufacturer unless exceptions are noted by Design-Builder.

All structural and miscellaneous metal required shall conform to the requirements of the Structural Metals and Metal Fabrications sections.

The supplier shall review the contract Drawings and installation requirements and shall make any modifications required for proper installation subject to acceptance by the Design-Builder.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.04. Coordination. The Design-builder shall coordinate the equipment specified herein with equipment specified elsewhere that will discharge into the conveyors or discharge out of the conveyors. This includes coordination of chute and flange connection dimensions.

1-2.05. Identification. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-2.06. Welding Certification. Shop and field welding procedures, welders, and welding operators shall be qualified and certified in accordance with the applicable provisions of the Structural Welding Code, AWS D1.1, of the American Welding Society.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, schematic and wiring diagrams, together with detailed specifications and data covering material used, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each conveyor shall include, but shall not be limited to, the following:

Screw Conveyors and Accessories
- Calculations for conveyor sizing, spiral strength (elongation), torque, and horsepower.
- Specifications for materials of construction.
- Detailed general arrangement drawings of conveyor system
- Dimensions and weight of overall unit
- Dimensions and weight of components (if shipped as components)
- Locations of lift points and tie-down points
- Details of all supports to be used by the unit when in place
- Dead and live load details for all support locations
- Rotating speed(s).
- Detailed shop drawings of screw conveyors and trough body.

Drive
- Name of manufacturer.
- Type and model.
- Type of bearings and lubrication.
- Input/output speed(s).
- Net weight.
- Service factor at installed horsepower.

Motors
- As specified in the Common Motor Requirements for Process Equipment section.

Seismic Design Requirements
- Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance information shall be submitted as required in the Submittals Procedures section. The operation and maintenance manuals shall be in

addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. SPARE PARTS AND ACCESSORIES. The Conveyor supplier shall propose a list of spare parts and pricing per General Terms and Conditions.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The inclined screw conveyor transports cake from belt filter press to the dumpster. Motorized gates are located on the bottom of the horizontal shaftless conveyor that permits cakes to fall into the dumpster. Each conveyor is controlled from a LCP using a control selector switch.

The conveying units shall be suitable for the following service conditions:

Seismic design requirements and site elevation.	See the Meteorological and Seismic design Criteria Section
Type of environmental exposure.	Outdoor (covered)
Ambient air temperature range.	24 to 106 F
Type of solids.	Belt filter press sludge
Maximum solids concentration, by weight.	62.5 lbs/cu ft
Material density.	60 lbs/cu ft

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Conveyors shall be designed for the following performance and design requirements:

Conveyor tag numbers.	DWT-COS-0001, DWT-COS-0002, DWT-COS-0003	
Screw conveyor type.	Shaftless	
Design capacity (wet).	Required to discharge cake from belt filter press	100 ft^3/hr
Minimum screw diameter.	Per Dewatering System Supplier	in
Approximate length.	See Drawings	ft
Maximum screw speed.	20	rpm
Angle of incline.	Refer to Drawings	deg
Motors.		

Maximum size.	5 hp
Reversing.	Yes

2-3. ACCEPTABLE MANUFACTURERS. Shaftless screw conveyor manufactures shall be, JDV Equipment Company, Spirac, Custom Conveyor, KWS Manufacturing Co., or equal.

2-4. MATERIALS.

Flights.	High tensile strength steel, 304L SS or 316L SS
Trough and cover.	316L stainless steel or 304L SS
Conveyor supports.	316L stainless steel or 304L SS
Discharge chute.	316L stainless steel or 304L SS
Slide gates.	316L stainless steel or 304L SS

2-5. CONSTRUCTION. Each screw conveyor shall consist of troughs, covers, shaft seals, drive units, and support structure.

Conveyor manufacture shall provide safety equipment and safety guards as required by OSHA and as indicated in ASME B20-1, Safety Standards for Conveyor and Related Equipment. Unless otherwise indicated, safety guards shall be in accordance with the General Equipment Stipulations section.

Conveyor configuration shall be based on the Drawings. The Design-builder shall coordinate the conveyor dimensions with equipment specified elsewhere. The Design-builder shall be responsible for taking field measurements.

2-5.01. Conveyor Supports. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the Drawings and as required by the supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and the tail end of the trough plus intermediate supports at a maximum of 12 foot intervals. All shop welding shall conform to the latest standards of American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.

Conveyor supports shall be designed for a minimum live load as specified herein. All structural supporting members shall be designed such that the ratio of the untraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z-Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the AISC

allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the screw conveyor drive motors.

2-5.02. Flighting. Shaftless screw conveyors shall consist of spiral flighting only attached to a flanged connecting plate. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.

Each screw conveyor shall be provided with inner and outer spirals to increase axial strength and capacity. Conveyors shall have an inner flight thickness shall not be less than 3/4 inch and outer flight thickness shall not be less than one inch. Minimum cross sectional area for conveyors having a diameter smaller than 15 inches shall be 2.9 in^2 and conveyors having a diameter of 15 inches and larger shall be 4.3 in^2. The spiral flights shall be designed for the maximum torque requirements of the equipment specified. The "spring effect" of the spiral shall not exceed 30 mils per foot of length assuming the conveyor is completely full (100% fill factor) of the material specified herein. Flights shall be formed from cold spring steel having a minimum 72,000 psi tensile strength and a minimum 220 Brinell hardness.

Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled and shall be made according to the manufacturer's recommendations. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral and shall form a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating matching flange and shall be bolted to the spiral connection plate.

2-5.03. Troughs. Troughs shall be U-shaped and shall conform to Conveyor Equipment Manufacturers Association (CEMA) 300. Troughs shall be minimum1 /8 inch [3.1 mm] thick and shall be equipped with inlet and discharge flanged connections where indicated on the drawing. The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging. The portion of each trough that is not covered by the inlet opening shall be covered. Covers shall conform to CEMA 300 and shall be bolted and gasketed to the conveyor. The covers shall be manufactured in less than 4 foot lengths to allow for access. Stiffeners shall be placed across the top of the trough and fastened to both sides of the trough to maintain trough shape and act as a seal face for the covers. A continuous neoprene gasket shall be applied to entire top face of trough top flange and stiffeners. Support saddles shall be provided on the bottom of the troughs where indicated on the Drawings or as recommended by the manufacturer. Maximum spacing shall be 12 feet.

Wear liners shall cover the bottom 180 degrees of the trough. Wear liners shall be ultra high molecular weight (UHMW) polyethylene. The wear liners shall be

manufactured in sections four feet or less to allow for replacement. Holddown bars shall be provided to minimize vertical movement of the flights.

Flushing connections shall be provided where required. The flushing connection shall be a minimum 1 inch NPT, welded to the trough.

Drain connections shall be provided where required. The drain connection shall be a minimum 4 inch flanged, welded to the trough.

2-5.04. Drive Shafts. Not used.

2-5.05. Shaft Seals. Not used.

2-5.06. End Bearings. Not used.

2-5.07. Intermediate Bearings. Not used.

2-5.08. Fasteners. All bolts, nuts, washers, and other fasteners shall be constructed of stainless steel.

2-5.09. Fabrication. All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped.

All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces. Particulate matter shall be removed from piping and welds. Welds shall be either mechanically cleaned or pickled or passivated.

2-6. DRIVE UNITS. Each conveyor shall be driven by an electric motor through either a chain, belt, or direct drive gear reducer. Drive units shall be designed for 24 hour continuous service.

2-6.01. Belt Drive. When required, belt drives shall be either V-belt or cogged timing belt. V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards - Multiple V-Belt Drives" published by the Mechanical Power Transmission Association (MPTA). Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 4 to 1. Each belt drive shall include a sliding base or other suitable means of tension adjustment.

2-6.02. Gear Reducers. Gear reducers shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout. Gear reducers shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the maximum thrust during startup of a conveyor completely full (100 percent fill factor) of the

material specified herein, and shall have a minimum ABMA L_{10} Life Rating of 100,000 hours. The reducers shall be standard air-cooled units with no auxiliary cooling allowed. The gear housing shall be of 30,000 psi cast iron, with removable inspection cover(s), oil breather(s), oil level indication, fill and drain holes with plugs; gearing lubricated through an oil bath for the mounting position and inclination required. The gear reducer shall be sized with a torque service factor of 1.5 based on motor nameplate, at the driven (output) shaft speed, whichever is greater. Gear motors in which the motor is integral with the gear reducer is not acceptable.

2-6.03. Electric Motors. Refer to the specification section listed in 01100 for the electrical motor requirements. Maximum motor speed shall be 1800 rpm.

2-6.04. Electrical. Electrical package including outdoor rated air-conditioned (if required) NEMA rated electrical enclosure, motor starters, variable frequency drives, circuit breakers, disconnect switch, etc. shall be furnished by the supplier to provide a completely system.

See electrical sections as identified in 01100 Section for electrical requirements.

2-7. ACCESSORIES.

2-7.01. Chutes. Inlet and discharge chutes shall be provided where indicated on the Drawings. Chutes shall be a minimum 10 gage thickness. Chutes sides shall not be sloped more than 70 degrees. Deflector plates shall be attached to the inside of the chutes to limit falling velocities, when the material drop is greater than 4 feet. Deflector plates shall not be sloped more than 70 degrees. Chutes connected to the screw conveyor shall be flanged to match the conveyor connection.

2-7.02. Flexible Connections. Not used.

2-7.03. Automatic Lubrication. Not used.

2-7.04. Slide Gates. A Flanged drip-less slide gate shall be provided for the screw conveyor discharge opening closest to the inclined screw conveyor where indicated on the Drawings. Gate surfaces in contact with the conveyed material shall be constructed of minimum 1/4 inch thick Type 316 stainless steel. All other surfaces shall be constructed of 1/4 inch thick, Type 316 stainless steel materials. All welding shall be per AWS standards. The gate blade shall be constructed of Type 316 stainless steel. The gate blade shall be supported on 1-1/4 inch stainless steel rollers, which are located out of the material flow. The rollers will include bronze bushings, which require no lubrication. The gate blade leading edge shall be beveled to facilitate its travel through the material being handled. The gate shall be provided with a ramping mechanism to help force the gate blade against the seal. The retract frame shall incorporate expanded metal guards for safety purposes.

Gate wiping seals shall be made of UHMW polyethylene. The seals shall contact the top of the gate blade along the perimeter of the throat opening. The seals shall be retained by a bolted steel bar which forms the inlet throat lining of the slide gate.

Supplier shall provide all supports for the actuator. Supports shall resist all loads imposed by the actuator, including thrust during operation.

2-7.04.01. Manual Actuator. Not used.

2-7.04.02. Pneumatic Actuator. Not used.

2-7.04.03. Electric Actuator. The slide gate shall have an electric actuator. Each electric actuator shall be furnished complete with a motor, gearing, handwheel, configurable output relays, torque sensors, lubricants, wiring, and terminals. Each actuator shall be constructed as a self-contained unit with a ductile iron or aluminum alloy housing, and shall be integrally assembled on the applicable gate. Housings shall have two O-ring seals, one on the controls compartment and one on the terminal cover.

Motors shall be totally enclosed, high torque design made expressly for valve and gate actuator service, capable of operating the valve or gate under full differential pressure for two complete strokes or one complete cycle of travel without overheating. Motors shall be designed in accordance with NEMA standards and shall operate successfully at any voltage within 10 percent above or below rated voltage. Motor bearings shall be permanently lubricated. Motors shall be provided with stall, temperature, loss of phase, and reverse phase protection. Actuators shall be capable of indicating phase loss.

Power gearing shall consist of hardened steel spur or helical gears and alloy bronze or hardened steel worm gear, all suitably lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter. Steel gears shall be hardened to not less than 350 Brinell. The use of planetary or cycloidal gearing or aluminum, mild steel, or nonmetallic gears will not be acceptable. Gearing shall be designed to be self-locking so that actuation of a torque switch or electronic torque protection device by a torque overload condition will not allow the actuator to restart until the torque overload has been eliminated.

Torque and thrust loads in both closing and opening directions shall be limited by a torque sensing device. Torque settings shall be adjustable and shall be indicated locally. The adjustment shall permit a variation of approximately 40 to 100 percent or rated torque.

2-8. CONTROLS. Motor starters and other controls not specified herein shall be furnished under the Electrical section.

The conveyor motor space heater shall be energized when the motor is not operating. The zero speed switch shall be powered from the control panel, and shall de-energize the motor starter if energized while the conveyor is not running. The conveyor shall shut down when the emergency stop switch is activated. Shut down by any safety or equipment protection devices shall require reset at the control panel.

2-8.01. Conveyor Mounted Switches. Conveyor mounted switches shall be furnished with standard watertight covered terminal strip junction box and 1/2 inch threaded conduit connection. Each switch shall be furnished and mounted as an integral part of the conveyor equipment and framework. All switches shall have 10 ampere, 115/120 volt ac, 60 Hz, rating.

2-8.01.01. Zero Speed Switch. Not used.

2-8.01.02. Emergency Stop Switches. Screw conveyors shall be equipped with two emergency stop safety switches, each with two normally closed double break contacts. Contacts shall be manually reset. Switches shall be equipped with a latching mechanism and a weight and cable along the length of the conveyor for operation of the switch. Switches shall be opened by cable linkage mounted on all sides of the conveyor. Cables shall be plastic covered metal cable (blaze orange color) and shall be located along the conveyor within easy reach of operating personnel who may be maintaining or observing the operating conveyor.

PART 3 - EXECUTION

3-1. INSTALLATION. Each screw conveyor shall be installed in accordance with Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An installation check by an authorized representative of the manufacturer is not required.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. TESTING. Prior to startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance as determined by means of a functional test. Any

equipment or components that fail this functional test shall be repaired or replaced at no cost to the Owner and re-tested.

Following the functional tests, the equipment shall be tested to confirm it can meet the specified performance and design requirements.

3-4. TRAINING. Not used.

End of Section

Section 43 05 21

SEAL WATER STATIONS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of seal water stations for the application types as stated in the pump specification sections. Seal water stations shall be furnished complete with all fittings, unions, valves, gauges, switches, piping, and other accessories specified herein or otherwise required for proper operation.

1-2. GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

Components of the seal water stations shall be the latest standard products of manufacturers regularly engaged in the production of equipment of this type.

1-2.01. Coordination. When two or more units of the same class of equipment are required they shall be the product of a single manufacturer; however all of the component parts of the system need not be the products of one manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Identification. All seal water stations shall be provided with a number plate with text as follows:

"SEAL WATER STATION – PUMP – [*pump designation*]"

where pump designation refers to the pump tag number as listed in the specifications or shown on the drawings. The location of number plates and the method of fastening shall be acceptable to Design-Builder. Numerals shall be at least 1 inch high and shall be black baked enamel on anodized aluminum plate.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each item shall include, but shall not be limited to, the following:

Name of manufacturer.
Type and model.
Construction materials, thicknesses, and finishes.
Setpoint adjustment range.
Pressure and temperature ratings.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Seal water stations shall be designed for the following requirements unless otherwise indicated:

Max design pressure	200 psig
Inlet working pressure	To be determined by Design-Builder
Outlet working pressure	To be determined by pump supplier
Temperature range	40 to 150 °F
Flow capacity	
Double mechanical seal	0.1 to 1 gpm
Single mechanical seal	3 to 5 gpm
Packing box	3 to 5 gpm
Vertical turbine pump	0.75 gpm per inch of shaft diameter

2-2. MATERIALS.

Pipe	1/2 inch Hard drawn copper tubing, ASTM B88, Type L for line piping with solder joint fittings. 1/4 inch ASTM B43. red brass, seamless, regular weight for instrument piping.
Strainers	Y-pattern type with bronze body, threaded ends, and monel or stainless steel screens (40 mesh for single mechanical seals and packing, 100 mesh for double mechanical seals). The blowoff from each strainer shall be equipped with a shutoff valve. Hoffman ITT “Series 400” or Metraflex “Model BS”.

Pressure Gauges	Liquid filled indicating dial type with 1/4 inch NPT connections, 2-1/2 inch dial, A316 stainless steel Bourdon tube, stainless steel rotary geared movement, stainless steel case, adjustable pointer, and polycarbonate or shatterproof glass window. The pointer shall span not less than 200 degrees nor more than 300 degrees. Indicating units shall be psig. Ashcroft, Duralife “Type 1009”, or Weiss Instruments, Inc.
Pressure Switches	Diaphram actuated type with a weatherproof housing, Teflon coated diaphragm, viton seals, and a stainless steel connection port. Ashcroft, Barksdale, NeoDyn, Mercoid Controls, or S.O.R.
Flow Switches	Vane-style variable area rotameters with scale pointers and adjustable switch contacts. Universal Flow Monitors “Series SN” or “Series LL”, as required by the application.
Sight Flow Indicators	Ball or paddlewheel type with threaded end connections.
Orifice Plates	Flow control orifice plates of diameter and type as recommended by the pump manufacturer.
Flexible Connections	Tygon “B-44-4X I.B.” tubing with Tygopure Reusable Fittings.
Ball Valves	Inline, two-piece, end entry, regular port with threaded end connections. Bronze body and trim with reinforced Teflon seats, seals, and washers. As manufactured by Cobraco Industries “Apollo 70-100 Series” or Powell “Fig 4210T”.
Globe Valves	Inline, metal disc, threaded bonnet, rising stem, with threaded end connections. Bronze body and trim. As manufactured by Milwauke “502”, Stockham “B-16”, or Walworth “Fig 3058”. Globe valves for Type A Stations on vertical diffusion vane shall be throttled to 25 percent open to permit some bypass flow around the solenoid valve to maintain lubrication flow around bearings.

Check Valves	Class 125 Horizontal swing, threaded bonnet type, ASTM B62 bronze, threaded end connections, -20 to 212°F temperature limits, Stockham “B-321”, Walworth “Fig 3406”.
Solenoid Valves	Two-position, normally closed, pilot operated with threaded end connections. Solenoid valves shall be 120 volt, 60 Hz, with class F insulation and rated for continuous duty. Bronze body with Buna-N or Teflon trim. As manufactured by ASCO “8210 Series”.
Pressure Regulating Valves	Direct acting, globe type valve with threaded connections and union assembly. Bronze body and cover, stainless steel trim, reinforced neoprene diaphragm, Buna-N disc, and stainless steel trim. As manufactured by Cla-Val “Model 990”, Cash-Acme, or Watts.

2-3. SEAL WATER STATIONS. Schematics of the different types of seal water stations are shown in Figure 1 – 43 05 21-F1. The following descriptions are for each types of seal water stations specified herein:

External Water Source Type

Type A	Solenoid valve, flow switch
Type B	Solenoid valve, pressure switch
Type C	Solenoid valve downstream of pump seal
Type D	Solenoid valve, simplified station

Re-circulating type

Type E	Re-circulating from pump discharge to pump seal
Type F	Re-circulating from pump seal to pump suction

2-4. ACCESSORIES.

2-4.01. Pressure Gauges. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade 1A or better.

The range shall be selected so that the normal operating reading is near the midpoint of the scale.

Each gauge shall be provided with a threaded end ball-type shutoff valve.

2-4.02. Pressure Reducing Valves. Each pressure reducing valve shall be designed to provide tight shutoff under conditions of no flow and shall not “hunt” under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.

2-4.03. Pressure Switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switch wetted parts shall be compatible with the process fluid.

Switches shall have a fixed deadband and shall be auto-reset type. Switches shall be SPDT, rated at least 10 ampere at 120 volts ac.

Each switch shall be provided with a threaded end, ball-type shutoff valve.

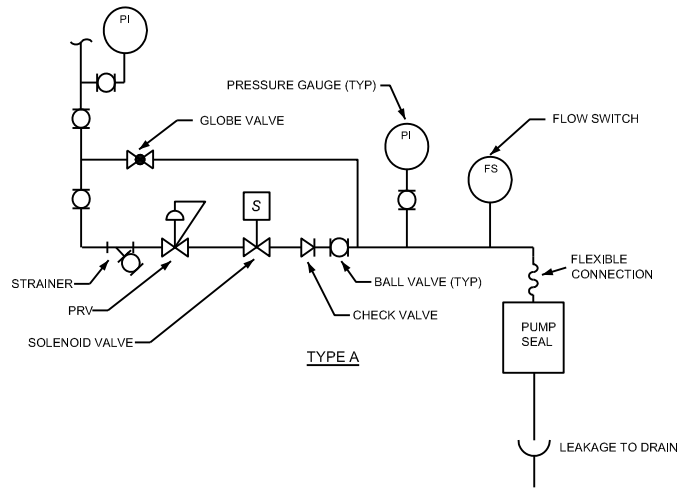
2-4.04. Flow Switches. Switches shall be SPDT with contacts rated at least 10 ampere at 120 volts ac. Switches shall be suitable for a flow of 20 to 100 percent of the required flows specified herein.

PART 3 – EXECUTION

3-1. INSPECTION. All piping and equipment shall be inspected for damage and cleanliness before being installed. All strainer elements shall be removed, cleaned, and reinstalled. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Design-Builder. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3-2. INSTALLATION. All equipment shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle any portion of the station for in-place maintenance. Unions shall be required at all solenoid valves and pressure reducing valves. Installation shall be in accordance with the manufacturers’ recommendations.

End of Section



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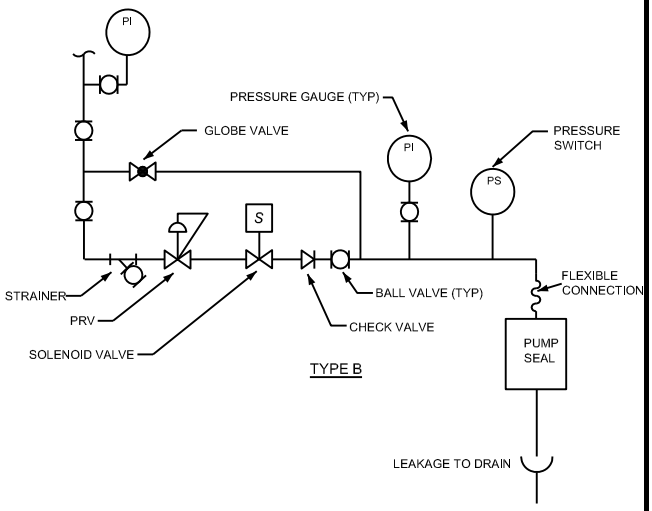

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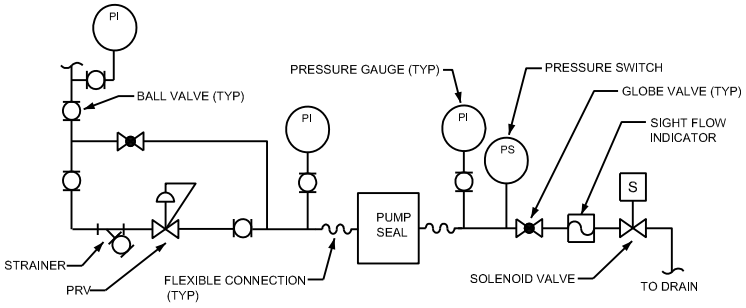

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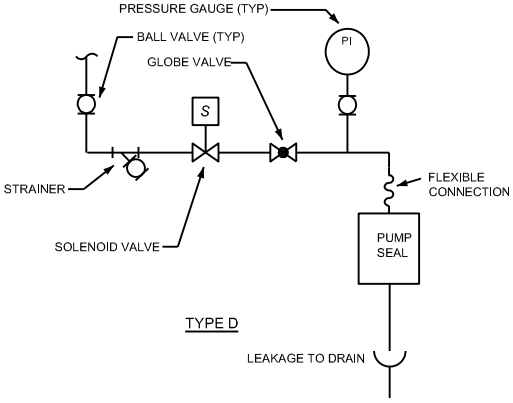
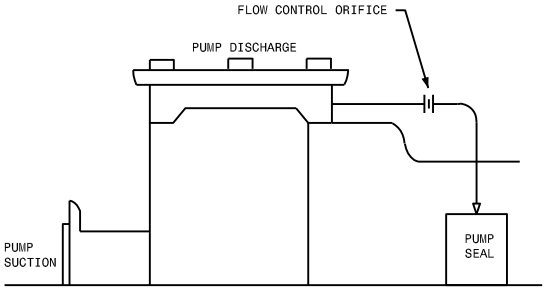
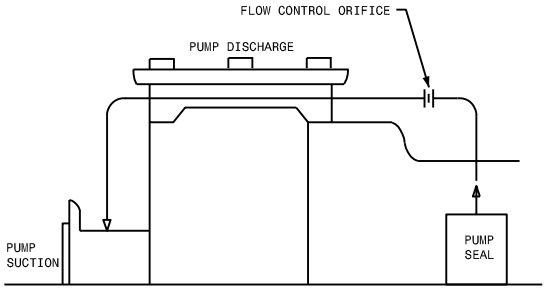


TYPE D

EXTERNAL WATER SOURCE TYPE



TYPE E



TYPE F

RECIRCULATING TYPE

SEAL WATER STATION ALTERNATIVES

BLACK & VEATCH	SEAL WATER STATIONS	FIG 1-43 05 21

Section 43 05 41

CHEMICAL STORAGE TANK INSTALLATION

PART 1 - GENERAL

1-1. SCOPE. This section covers installation of tanks for aboveground bulk storage of chemical solutions.

Tanks, piping, pipe supports, valves, and accessories which are not an integral part of the tanks are covered in other sections.

1-2. GENERAL.

1-2.01. Coordination. The tanks are to be installed in areas of limited access. The timing of installation for the tanks shall be coordinated with building construction and with construction under other contracts as needed.

1-3. DELIVERY, STORAGE, AND HANDLING. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3-1. INSPECTION. All equipment and accessories shall be inspected for damage and cleanliness before being installed. Any item damaged or contaminated in handling on the job shall not be used unless it has been repaired and re-cleaned to the original requirements by Contractor. Such items shall be segregated from clean or undamaged items and shall be inspected and approved by Owner or his representative before its use.

3-2. PREPARATION. The concrete base for each tank shall be constructed in accordance with the Cast-in-Place Concrete section and shall be level and smooth to the tolerances recommended by the tank manufacturer.

3-3. INSTALLATION. When the tank containment area has a corrosion protection system specified, the protection system shall be applied and cured to the tank base before each tank is installed. Each tank shall be installed in accordance with the tank manufacturer's recommendations, the applicable governing standard, and to the satisfaction of Engineer. At any location where a

containment corrosion protection system lining is penetrated including anchorage of a tank, a caulking material suitable for the specified service conditions and recommended by the protection system manufacturer shall use to seal around the penetration. Grouting under the tank, if recommended by the tank manufacturer, shall be accomplished with nonshrinking grout as specified in the Grouting section.

3-4. FIELD QUALITY CONTROL.

3-4.01. Lining Testing. When a corrosion resistant lining is specified, the liner shall be tested after installation for damage occurring during installation. The lining shall be tested for holidays and pinholes using a low-voltage unit holiday detector approved by the coating manufacturer and acceptable to Engineer. Locations where holidays and pinholes are detected shall be marked for repair and retested after repair work has been completed. Contractor shall certify the lining is free of holidays and pinholes.

3-4.02. Leakage Testing. After installation and testing of any lining, each tank shall be filled with water to the level required and allowed to stand for a period of not less than 48 hours. During testing, flanged connections may be plugged by installing temporary blind flanges on the outside of the tank, but shall not be blocked or plugged on the inside. All leaks or indication of leaks shall be repaired by the tank manufacturer and the tank re-tested to the satisfaction of Engineer.

3-5. CLEANING. When installation and testing have been completed and all connections have been made, all tank surfaces, both interior and exterior, shall be thoroughly cleaned as recommended by the tank manufacturer and to the satisfaction of Engineer. Abrasive cleaning agents shall not be used.

End of Section

Section 43 11 15

DRY SCREW POSITIVE DISPLACEMENT BLOWERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of electric motor driven, rotary dry screw, positive displacement blower packages to be installed as indicated on the Drawings and as required.

Each blower package shall be a factory fabricated skid and shall include blower, motor, inlet filter, inlet silencer, discharge silencer, belts, sheaves, belt guard, flexible connections, safety valve, discharge check valve, instrumentation, controls, and vibration isolators. The screw blowers shall be single-stage, electric motor-driven and must deliver 100% oil-free, pulsation-free air. The screw blowers must feature internal compression. Twisted rotors are not acceptable. Blowers shall each be driven by a Variable Frequency Drive (VFD). VFDs shall be provided by others. All components with the exception of the control panel, intake filters and VFDs shall be mounted within an acoustic enclosure and the blower shall match the air demand by continuously changing the speed of the drive motor to ensure the air net pressure is maintained. Each blower package shall be complete with all spare parts, accessories and appurtenances indicated on the drawings, specified herein, or otherwise needed for proper operation.

Blower System	Process Blowers
Blower Location	Outdoors adjacent to BNR Tanks
Number of blowers	3
Blower tag numbers	AER-BL-0101
	AER-BL-0201
	AER-BL-0301

Piping, pipe supports, valves, and accessories that are not an integral part of the equipment or specified herein are covered in other sections.

1-2. GENERAL.

1-2.01. Coordination. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations furnished by the equipment manufacturer unless exceptions are noted by the Design-Builder.

All blowers specified herein shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

The blower unit shall be a current standard product of the blower manufacturer and shall be a fully factory assembled package by one of the manufacturers specified here in or by one of the blower packagers specified herein. All accessory items, including the sound enclosure, shall be furnished by the blower manufacturer or the blower packager specified herein.

For general construction contracts and aeration applications, Design-Builder shall be responsible for coordinating the blowers with the equipment specified in the diffused aeration equipment section. Design-Builder shall be responsible for any changes required in the blower design resulting from changes in the diffused aeration equipment design, including pressure losses through the submerged piping system and diffusers.

Unless exceptions are noted by Design-Builder, the equipment arrangement and piping may be modified in accordance with the recommendations of the equipment manufacturer to suit the equipment furnished. All needed modifications shall be reviewed by the Design-Builder and shall be performed by the Design-Builder at no additional cost to Owner.

1-2.02. Additive Pricing.

Air Blower Controls System Supplier (ABCSS). As an additive price option, Controls integration and programming can be performed by the specified Blower Manufacturer or Blower Packager or by an I&C subcontractor provided by the specified Blower Manufacturer of Blower Packager. The ABCSS shall meet the following criteria:

Selection Procedure for Control System Supplier
(1) Does the ABCSS have at least 5 years in-house I&C experience with the dissolved oxygen/most open valve method of blower control, along with the capabilities to construct and program the Blower Master Control Panel (BMCP)? If "Yes," go to Item 2. If "No", go to Item 3.
(2) ABCSS may use their own I&C department. Proof of experience will be required. Submit references, complete with contact information. Projects cited must be in full-scale operation. Mandatory meetings will be required between ABCSS, Design-Builder, and I&C Subcontractor in order to coordinate installation of flowmeters, control valves, dissolved oxygen meters, and any other appurtenances required for a fully functioning air delivery system.

Selection Procedure for Control System Supplier	
(3)	Does the ABCSS have a working relationship with an I&C Subcontractor? The ABCSS shall provide references from the I & C Subcontractor, complete with contact information, including a minimum of three completed jobs (in full-scale operation) in operation for at least 5 years. The completed jobs shall have used dissolved oxygen/most open valve blower control, and the I&C Subcontractor must have provided the BMCP along with all of the programming. If "Yes", go to Item 4. If "No", go to Item 1.
(4)	ABCSS may retain the services of their own I&C subcontractor. Proof of experience will be required. Mandatory meetings will be required between ABCSS, ABCSS's I&C Subcontractor, Design-Builder, and I&C Subcontractor. Purpose of the meetings shall include but not be limited to coordination of the BMCP and plant SCADA system.

As part of this optional pricing, please also include DO analyzers, flow meters and flow control valves.

Butterfly modulating valves, flow meters and dissolved oxygen analyzers as specified in Industrial Butterfly Valves Section 400564, Flow Instruments Section 407100, and Process Analytical Instruments Section 407500 shall be furnished by the Blower Manufacturer. For this additive pricing, complete controls system integration and programming shall be performed by the Blower Manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories (UL) safety requirements.

1-2.04. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.05. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers in accordance with the Equipment and Valve Identification section.

1-2.06. Nameplates. Each blower and accessory component having a tag number as indicated on the Drawings or specified herein, shall be provided with a permanent number plate in accordance with the Equipment and Valve

Identification section. The location of number plates and the method of fastening shall be acceptable to Design-Builder.

1-2.07. Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Lubricant type shall be as recommended by the equipment manufacturer.

1-2.08. Abbreviations. Reference to standards and organizations in the Specifications shall be by the following designations:

ABMA	Antifriction Bearing Manufacturers Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
Fed Spec	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers
MIL	Military Specification
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NPT	National Pipe Thread
OSHA	Occupational Safety and Health Administration
UL	Underwriters' Laboratories

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the contract drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but not be limited to the following:

Package

Letter from the blower manufacturer confirming blower package is fully shop assembled and will meet the performance requirements specified herein.

Dimensional drawings showing overall package dimensions, connection locations and sizes.

Package weight.

Blowers

Name of manufacturer.

Type and model.

Full rotative speed at rated condition.

Blower design maximum rotative speed.

Critical speed of the rotor.

Type of bearings, ABMA L_{10} life rating, and lubrication.

Connection sizes.

Maximum air temperature at discharge flange.

Maximum allowable forces and moments on blower inlet and discharge flanges.

Net weight of blower.

Net weight of heaviest single component requiring removal for maintenance.

Overall dimensions.

Complete performance curves or tables showing discharge pressure versus capacity and speed, blower and overall efficiency, and bhp at minimum and maximum ambient air temperatures and at standard conditions.

Reduced speed performance curve or tables for each 100 rpm increment at specified conditions including maximum, average, and

minimum temperatures and corresponding relative humidity where variable frequency drives are required.

Speed versus capacity equation or data table where variable frequency drives are required.

Shop painting data.

Anchor bolt location details.

Rubber-cork vibration isolator pads and their sizing information.

Maximum free field noise level at 3 feet.

Letter from the blower manufacturer confirming that the free field noise at three feet from the blower enclosure will not exceed the specified sound level while operating at the specified capacity.

Letter from the blower manufacturer confirming that the blower inlet and discharge noised across the entire Octave Band, including the inlet and discharge silencers, will not exceed the specified maximum allowable noise levels when operating at the specified capacity.

Motors

As specified in the General Purpose Induction Motors Section.

Letter from the blower manufacturer that the VFDs and motors have been coordinated.

Variable Frequency Drives

As specified in the Variable Frequency Drives Section.

Controls

Blower control panel layout including interior and exterior views.

Accessory device data including catalog cut sheets on all control components.

Wiring diagram.

Accessories

Name of manufacturer.

Equipment data indicating overall dimensions, connection sizes, weights and materials of construction, pressure losses, efficiencies, and noise attenuation as applicable.

Drawing showing internal silencer baffling and construction.

Sound attenuation at each octave band for each silencer.

Drawing showing internal construction of each silencer.

Inlet Filter Silencers

Manufacturer and model.

Sound attenuation at each octave band.

Filter particle arrestance and efficiency.

Filter material.

Filter housing dimensions.

Certified Shop Test Reports

Test data and results.

Sample calculations.

Package on additive pricing per Section 1-2.01.01

1-3.02. Operation and Maintenance Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

1-5. SPARE PARTS. The Supplier shall furnish all special tools and spare parts recommended by the manufacturers of equipment specified herein.

- Any special tools required for installation or maintenance of any of the furnished equipment shall be furnished.
- A complete itemized price list of all recommended special tools, spare parts, and consumables shall be submitted.
- A set of recommended spare parts and consumables for system startup and testing shall be furnished.
- A set of recommended spare parts and consumables for one year of operation from Date of Substantial Completion or Acceptance of Final Testing, whichever is later, shall be furnished.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS.

The blowers shall be suitable for the following service conditions:

Seismic and wind loading criteria	See the Meteorological and Seismic Design Criteria Section	
Barometric pressure	14.6	psia
Design maximum inlet air temperature	100	F
Design minimum inlet air temperature	36	F
Design relative humidity at maximum design temperature	40	%
Design relative humidity at minimum design temperature	10	%

Parts shall be interchangeable between units of similar size and capacity to extent practical.

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Blower units shall be designed for the operating conditions as follows:

Blowers

Service	Aeration		
Blower tag numbers	AER-BL-0101		
	AER-BL-0201		
	AER-BL-0301		
Installation	Outdoors		
Operation	Parallel and Stand alone		
Discharge pipe connection	Horizontal		
Inlet pressure at blower suction flange	14.2	psia	
Maximum inlet pressure loss including dirty inlet filter, inlet piping, inlet valves	0.3	psi	

Rated discharge pressure at the package outlet flange	10.3 (24.8)	psig (psia)
Minimum capacity at rated package discharge pressure, maximum inlet air temperature and relative humidity and rated operating speed	1,300	scfm
Turndown at rated discharge pressure, minimum inlet air temperature and relative humidity	420	scfm
Ratio of maximum rated blower operating speed at normal motor speed to maximum allowable blower speed	95	%
Ratio of rated discharge pressure at blower outlet flange to maximum allowable blower discharge pressure	80	%
Maximum rated speed of motor	3600	rpm
Maximum power required at rated discharge pressure, specified ambient temperatures and relative humidity range, and rated operating speed	71.25	bhp
Drive motor rating	75	hp
VFDs Required	Yes	

Intake Filter

Maximum initial pressure drop	2	in wc
Maximum face velocity at housing entrance	50	ft/min
Filter configuration	As indicated on the Drawings	
Particle arrestance (removal percentage/size)	99.97% for 1 micron and larger particles	

Minimum inlet connection	10	in
Inlet and discharge silencer		
Minimum octave band sound attenuation		
Octave band 63	27	dB
Octave band 125	31	dB
Octave band 250	31	dB
Octave band 500	29	dB
Octave band 1000	26	dB
Octave band 2000	24	dB
Octave band 4000	23	dB
Octave band 8000	21	dB
Maximum silencer operating temperature	350	°F
Maximum estimated free field noise level with piped inlet and discharge connections at rated operating speed, measured 3 feet from any surface of sound enclosure	80	dBA
Maximum overall vibration velocity of blower at any point on the blower skid at rated operating speed	0.45	in/sec
Discharge Flexible Connections*		
Discharge configuration	Side	
Number of arches	3	
Lateral movement capability	3	in
Axial movement capability	5-1/4	in
Lateral spring rates range	326	lb/in
Axial spring rates range	306	lb/in
Blower discharge connection size*	8	in
Maximum face-to-face length	16	in
Temperature rating	300	°F

Package Dimensions

Maximum Enclosure Length Including Discharge Flange Connection	80	in
Maximum Enclosure Width	60	in
Maximum Enclosure Height	77	in
Blower Discharge Connection Location	Short Side	
Blower Inlet Connection Location	Short Side	

(*) Flexible connection size shall match package discharge size. If size different than indicated here in, spring rates shall meet the flexible connection specifications indicated in Section 2-6.04.

Standard cubic feet per minute, scfm, is defined as air at 14.7 psia, 68°F and 36 percent relative humidity. Blowers shall be capable of providing the specified mass flow in scfm throughout the entire operating range including at the specified summer conditions.

2-3. ACCEPTABLE MANUFACTURERS. Blowers shall be as manufactured by Atlas Copco, Aerzen, or latest design of Gardner Denver Cycloblower and shall be packaged by Atlas Copco, Universal Blower PAC, or Excelsior Blower Systems without exception.

2-4. MATERIALS.

Casing and Impellers	Cast iron or ductile iron.
Shafts	High carbon steel or ductile iron; turned, ground and polished.
Timing Gears	Alloy steel.
Base	Fabricated steel.

2-5. CONSTRUCTION.

2-5.01. Casings. Casings shall be designed to withstand at least twice the specified discharge pressure and shall be reinforced with integrally cast ribs. Each casing shall be provided with tapped and plugged openings for casing and bearing drains and fittings for properly adding bearing and gear lubricant.

2-5.02. Impellers. The blower compression element shall comprise of helicoidal screw rotors, with lobes and flutes turning into each other. Rotors must feature internal compression. Twisted rotors are not acceptable. Some of the

compression shall take place within the blower element between the rotors and the rotor and casing. Impellers shall be statically and dynamically balanced. Each impeller/shaft shall be supported by anti-friction bearings.

2-5.03. Shafts. Shafts shall be cast integrally with the impeller or shall pass completely through the impeller. Stub shafts will not be acceptable. Impellers shall be securely attached to through shafts.

2-5.04. Timing Gears. The intermeshing timing gears shall ensure the rotors do not touch each other and maintain the requisite clearance between the rotors & ensure wear and tear is eliminated and no lubrication is required in the compression space. Timing gears shall be enclosed in oiltight housings and shall be splash or lubricated. Timing gears shall provide non-slip rotor timing.

2-5.05. Belts and Sheaves. All belts and blower and motor sheaves required for the blower shall be furnished. Belts and sheaves shall be of the heavy-duty "V" type with a horsepower rating of at least 1.4 times the motor nameplate horsepower. Belts shall be matched sets.

2-5.06. Seals. Seals shall be designed to prevent lubricant from leaking into the air stream as well as to prevent oil from leaking out of the machine. The seal shall consist of two rotary slip rings mounted in a retainer with an atmospheric air gap in the center.

2-5.07. Base Frame. A full length, common base shall be provided for each blower package. The base frames shall be constructed of cast iron or heavy steel plate and structural members and shall be designed for no measurable deflection with the equipment mounted thereon and the base frame supported from the floor. Each base shall be designed so that all equipment bolted to it can be removed without access to the underside, and for ease of cleaning. Structural stiffeners shall be located under the equipment at the equipment anchor points. A drip lip will not be required. The base shall be suitable for direct attachment to the foundation. Complete support of the inlet and discharge silencers, blower control panel and the acoustic enclosure shall be from the base frame. The blower supplier shall provide and install silencer supports for each blower package. The inlet filter shall be attached to the inlet silencer.

2-5.08. Silencers. Each blower shall be furnished with a silencer in the suction and discharge piping. Silencers shall be multi-chambered reactive type or combination multi-chambered reactive/absorptive type as required by the blower operating speed. Silencers shall be equipped with ported tubes and air passageways to reduce blower pulsations and system air noise from the blower. There shall be no “line of sight” passages within the silencer design. Each silencer shall be of all-welded steel construction with painted exterior surfaces and flanged connections with diameter and drilling conforming to ASME B16.1, Class 125.

2-5.09. Acoustical Enclosure. The acoustic enclosure shall be a self-supporting structure housing the blower, motor drive, and intake and discharge silencers and mounted on the package skid base. If material is friable, the enclosure shall be constructed of panels consisting of noise dampening material sandwiched between two metal sheets as required. If the material is non-friable such as foam rubber, the interior metal sheet is not required as long as sound attenuation is not compromised. The enclosure shall be provided with removable panels or hinged sections to allow routine blower and V-belt maintenance. A complete enclosure, enclosing the total blower package, including the silencers shall be provided. Partial enclosures are not acceptable.

The enclosure shall be designed to withstand the specified wind velocity without damage. All bracing and reinforcing members shall be integral to the enclosure. Blower oil drain piping shall be piped to outside of enclosure and terminated with a threaded pipe cap. Air piping shall be piped to outside of the enclosure and terminate with a pipe flange. The flanges shall be ASME B16.1, Class 125 diameter and drilling and shall extend not less than 4 inches outside of the enclosure for flange bolt removal.

An internal ventilating system shall be provided for the enclosure. The ventilation system shall utilize a 120 volt ac rated electric motor driven ventilating fan to draw ambient air into the enclosure for cooling the enclosed equipment prior to exhausting the air outside of the enclosure. Air inlet and exhaust openings shall have noise abatement features that meet the maximum noise level specified when the ventilating system and blower are operating simultaneously. The ventilating fan shall be powered and controlled through the blower control panel.

2-5.10. Anchor Bolts. Anchor bolts shall be per the General Equipment Stipulation and the Anchorage in Concrete and Masonry section.

2-6. ACCESSORIES.

2-6.01. Intake Filter Silencer. Each blower shall be provided with an intake filter silencer as part of the blower package. The blower package shall be provided with a flanged connection. Each filter silencer shall be a replaceable synthetic, pleated, dry filter element. Each filter shall be cartridge type. Filter silencers shall be suitable for continuous weather exposure in exterior locations.

Filter silencer shall be installed such that the outside air inlet of the filter unit shall be a minimum of 3 feet above the adjacent grade or roof. The filter silencer shall connect to the suction piping without reducers. Additionally, each inlet filter shall be provided with differential pressure switches to shut down the blower on high differential pressure across the inlet filter (dirty filter).

Filter silencer shall be Endustra.

2-6.02. Blowoff Silencers. Not used.

2-6.03. Vibration Isolator Base Pads. Rubber-cork vibration isolator pads shall be supplied by the blower packager for each blower.

2-6.04. Flexible Connections. An elastomeric, flanged, arched type flexible connection shall be provided in the suction and discharge piping adjacent to each blower as specified herein.

Each flexible connection shall be sized to allow piping movement without exceeding the blower manufacturer's force allowance at the blower flange. The number of arches shall be as specified herein or as needed to meet the specified spring rates and movement capabilities. The inlet connection shall be suitable for 7 psi vacuum service and the discharge connection shall be suitable for a pressure of 15 psig and a temperature rating of 300°F. Suction flexible connectors shall be single arch, Mercer “Type 450”, or equal. Discharge flexible connectors shall be Mercer “Type 450” with “Type 500” retaining rings and Kevlar reinforcement, or equal, with the number of arches, spring rate, and movement as indicated herein.

2-6.05. Valves.

2-6.05.01. Safety Valves. Each blower shall be provided with a safety valve, or pressure relief valve as indicated on the drawings, as recommended by the blower manufacturer. The safety valves shall be capable of protecting the blowers from damage due to operation with a closed discharge valve. The valves shall be suitable for temperature up to 300°F. Set points shall be at least 1 psi above the rated blower discharge pressure unless otherwise indicated.

2-6.05.02. Check Valves. An air check valve shall be installed in the discharge piping from each blower downstream of the discharge silencer as part of the factory piped package. See the Check Valve section (40 05 68).

2-6.06. Pressure Gauges. A pressure gauge shall be furnished and installed in the discharge piping of each blower and a vacuum gauge in the suction piping of each blower.

Pressure gauges shall conform to ANSI B40.1 and shall be of the indicating dial type with C-type phosphor bronze bourdon tube, stainless steel rotary geared movement, phenolic open front turret case, adjustable pointer, stainless steel or phenolic ring, and acrylic plastic or shatterproof glass window. All gauges shall be ANSI Accuracy Grade A. Gauges installed indoors shall be liquid filled.

The dial shall be 4-1/2 inch size with white background and black markings and shall have dual English and metric indication. The English units of measurement

shall be pounds per square inch and the metric units shall be kilopascals. The range for each discharge pressure gauge shall be from 0 to 15 psig. The range for each vacuum gauge shall be from 15 inches Hg vacuum to 0. Pointer travel shall be not less than 200 degrees nor more than 270 degrees.

All gauges shall be provided with 1/2 inch NPT connections. Each gauge shall be provided with a threaded end ball type shutoff valve as specified in the Miscellaneous Ball Valves section installed at the blower discharge piping connection.

2-6.07. Pressure Switch. A pressure switch shall be furnished and installed in the discharge piping of each blower. Each switch in the blower discharge piping shall have an adjustable range of 0 to 15 psig and shall be set lower than the relief valve setting. A pressure switch shall be furnished for installation across the intake filter pair. The switch across the intake filters shall have an adjustable range from 0 to 10 inches water column vacuum.

The pressure switch shall be field adjustable and shall have a trip point repeatability of better than 1 percent of actual pressure. The switch shall have one normally open and one normally closed contact rated 10 amps at 120 volt ac. The switch shall be wired to the blower control panel and shall shut down the blower on high discharge pressure or high pressure drop across the filter. Switches shall have a weatherproof housing and shall be as manufactured by Static-O-Ring Company, Mercoid Control, Barksdale, or equal.

2-6.08. Draft Gauge. A draft gauge shall be provided having a range from 0 to 10 inches water column shall be installed across each air filter or air filter silencer.

The gauge shall have minimum 3-1/2 inch dial, pressure taps, fittings for 1/4 inch metal tubing, vent valves, mounting brackets, and an adjustable signal flag.

The draft gauge shall be "Dwyer 2000 Series Magnehelic Differential Pressure Gages" manufactured by Dwyer Instruments, Inc. or equal.

2-6.09. Thermometers. A thermometer shall be provided for monitoring of temperature in the discharge piping. The thermometer shall be mounted on the blower control panel. The capillary routing shall not require disassembly for normal maintenance of the blower, motor or V-belts.

Thermometers shall be of the remote reading gas actuated dial type. Thermometers shall have a minimum dial size of 5 inches, an adjustable pointer, shall be accurate within 1 percent of full scale. Thermometers shall have both Fahrenheit and Celsius indication. Thermometers shall be furnished complete with a uniformly graduated dial indicator, armored capillary tube, bulb or temperature sensor, and thermowell. Unless otherwise indicated in the drawings

or Instrument Device Schedule, thermowells shall be weld mount style. Thermowells shall be AISI Type 316 stainless steel. Thermometer ranges shall be such that the normal operating reading will be near the midpoint of the range. The units of measurement shall be indicated on the dial face. Spare capillary length shall be neatly coiled and tied.

2-6.10. Differential Temperature Switches. Differential temperature switches shall be remote bulb type with single pole double throw ampere switches suitable for 120 volt ac. Temperature switches shall have NEMA 4 housings, stainless steel thermal well assemblies, and armored capillaries. Capillary length shall be sufficient for convenient mounting. Each differential temperature switch shall be wired to the blower control panel and shall shut down the corresponding blower on high differential air temperature across the blower.

2-6.11. Vibration Detection Systems. Not used.

2-7. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibrations shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the maximum unfiltered vibration velocity, as measured at any point on the machine, shall be as required.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8.

2-8. DRIVE UNITS. Each blower shall be driven by an electric motor through a belt drive as required. Drive units shall be designed for 24 hour continuous service.

2-8.01. Safety Guards. All belt drives, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.

2-8.02. Variable Frequency Drives. A variable frequency drive (VFD) shall be provided for each of the blower package by others. Variable frequency drives shall be as specified in the Variable Frequency Drives Section. The blower supplier shall coordinate with the motor and VFD manufacturers and be responsible for providing a motor and VFD which produces sufficient torque above the blower load curve to assure proper acceleration under all operating conditions. The blower supplier shall also coordinate with the motor and VFD manufacturers and be responsible for providing a motor with component mass

and spring constant such that torsional resonant frequencies do not occur in the system under all accelerating and normal operating conditions. The blower supplier shall also coordinate with the motor manufacturer and be responsible for providing a motor of adequate thermal design for the system inertia and load to permit one start per hour at rated temperature rise and two successive starts at 40 degrees C ambient without exceeding the motor insulation and component temperature limits.

2-8.03. Electric Motors. Electric motors shall be in accordance with the requirements of the General Purpose Induction Motors section.

2-9. CONTROLS.

2-9.01. Blower Motor Starters. Not used.

2-9.02. Blower Local Control Panel. Each blower shall be furnished with a local blower control panel. The power supply to the blower control panel shall be 120 volt, 60 hertz, single phase. The blower control panel shall be furnished with a main circuit breaker disconnect with a lockable operating handle on the exterior of the panel. The AIC rating of the main circuit breaker and motor circuit protectors shall be 22,000 amperes at 480 volt. The blower control panel shall be furnished with all control power transformers, gauges, relays, pilot devices, indicators, etc., required to monitor, protect and shutdown its respective blower.

The control panel shall be furnished with a Local-Off/Reset-Remote selector switch for each blower. The switch shall be lockable in the center Off/Reset position. In the Local position the blower shall run and blower speed shall be set manually at the blower control panel. In the Off/Reset position the blower shall stop and reset any equipment protection/alarm conditions. In the Remote position the control panel shall accept a normally open relay contact for blower start and stop control and a 4-20mA blower speed control signal from PLC. The selector switch shall be furnished with a contact for remote indication of Remote position.

The control panel shall be mounted separate from the blower package to prevent vibration from affecting panel mounted components, as shown on the drawings. All components installed in or on the panel shall be rated for the control power supply as required. If voltages other than the specified control power supply is required, the panel supplier shall furnish the required control power transformers.

The control panel shall be furnished with a white control power on indicating light, a green blower stopped indicating light and a red blower running indicating light.

The control panel shall be furnished with amber indicating alarm lights for high differential air temperature across the blower, high discharge pressure, high differential pressure across intake filter, and motor/VFD overload/fail.

Indicating lights shall be provided for each blower.

In lieu of the lights indicated, all items may be provided on a touch screen rather than indicated by lights if preferred by the vendor. Touch screen and HMI shall be rated for 163F.

For all conditions above requiring amber indicating lights an alarm relay shall be furnished with two normally open contacts rated 10 amperes at 120 volt ac. The normally open contacts shall close for any alarm condition and shall be used for remote annunciation of a blower alarm and shall shut down the blower.
The blower control panel shall be furnished with a normally open dry run contact rated 10 amperes at 120 volts ac for remote indication of blower running.

The panel shall be furnished with a warning and alarm light test pushbutton that illuminates all panel mounted lights when pushed. The panel shall be provided with an elapsed time hour meter for displaying the running time of each blower.

The blower control panel shall provide the following outputs to the Plant Control System:

- Blower Alarm
- Blower Running
- Blower In-Remote
- Blower Speed Indication

The blower control panel shall receive the following outputs from the Plant Control System:

- Blower Speed Control
- Blower Run Command

The blower control panel shall provide the following outputs to the Variable Frequency Drive:

- Blower Speed Command
- Blower Run Command

PLC of plant control system and the associated programming of the automatic blower control shall be provided by I&C System Supplier of Specification and the Design-Builder. For VFD driven blowers, the blower manufacturer shall coordinate with Design-Builder and provide air flow versus speed relationship for the blowers being provided. In addition, the blower manufacturer shall provide information on the minimum acceptable operating speed and the VFD shall have protection controls to keep it from being operated below the minimum safe speed.

2-9.03. Panel Fabrication Requirements. The control panel furnished shall conform to the requirements of NEMA ICS-6. Panels shall be rated NEMA Type 4X and shall be constructed from stainless steel.

All panel wiring shall be of the type normally furnished by the manufacturer with the following exceptions. All power and control wiring for 120 volt circuits shall be stranded copper #12 AWG minimum. All power and control wiring shall have a 600 volt insulation rating and a nominal maximum operating temperature of 90 degrees C. All analog circuits shall be #16 AWG twisted shielded pair rated for at least 300 volts. Conductor insulation for power, control, and analog circuits shall have a moisture-resistant and flame-retardant covering.

All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and with space equal to at least 40 percent of the depth of the duct remaining available for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal clamping voltage of 200 volts. Surge protectors shall be of nonfaulting and noninterrupting design, with a response time not to exceed 5 nanoseconds. Surge protectors shall be manufactured by Innovative Technology, Power Integrity Corporation, or Transtector.

Terminal blocks shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strips, covers, and pressure connectors. Terminals shall be labeled to agree with the identification on the System Supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. At least 25 percent spare terminals shall be provided. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Nameplates shall be provided on the face of each panel and on each individual control or pilot device. Panel nameplates shall be made of laminated phenolic material with engraved letters approximately 3/16 inch high extending through the black face into the white layer, and shall be secured firmly to the panel.

All control and pilot devices furnished shall be NEMA 4 rated, heavy duty oiltight.

2-9.04. Factory Panel Test. Before shipment, the panels shall be electrically tested by the manufacturer.

2-9.05. Sequence of Operation. The blower sequence of operation shall be as indicated below:

Startup Sequence:

1. Energize blower motor.
2. Release control to PLC to adjust VFD to achieve air flow rate.

Shutdown Sequence:

1. De-energize blower motor.

2-10. SHOP PAINTING. Equipment and items furnished as specified herein shall be furnished with shop coatings suitable for permanent installation and operation in accordance with the requirements in the General Equipment Stipulations section.

2-11. SHOP TESTS. Variable speed blowers shall be tested over the entire specified capacity range with contract motors and variable frequency drives.

2-11.01. Operational Test. Each blower shall be shop tested by the manufacturer for vibration and pressure developed and shall be checked for leaks, faulty components and controls.

2-11.02. Slip Test. A one psi slip test shall be performed on each blower. The test shall consist of an ASME PTC-9 slip test, with calculations correcting the results to field conditions, to ensure compliance with specifications. The test shall be in accordance to the paragraph, 4.52 of ASME PTC-9 slip test. In lieu if ASME PTC-9, a ISO 1217 or ASME PTC-13 test is also acceptable.

2-11.03. Vibration Test. A vibration test shall be performed on each blower. When the vibration test indicates an overall vibration velocity greater than 0.45 inches per second, the manufacturer shall be responsible for performing and reviewing a frequency analysis. The manufacturer shall make corrections as necessary, and confirm that the vibration velocity will not be detrimental to the equipment. An overall vibration velocity greater than 1.0 inch per second shall be sufficient cause for rejection of the equipment.

Defective equipment and controls disclosed by the tests shall be replaced and each unit placed in satisfactory operating condition before shipping.

A PDF of the test report complete with performance curves, data, and all calculations shall be submitted to the Design-Builder in accordance with the submittals section.

PART 3 – EXECUTION

3-1. INSTALLATION. Each blower unit will be installed in accordance with Equipment Installation section and as specified herein.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

The manufacturer's representative shall verify:

a. Each blower discharge isolation valve is fully open.
b. Each check valve is properly installed.
c. Piping is installed such that excessive force is not being exerted on the blower flanges.
d. No resonance vibration conditions are occurring within the blower package or air piping.

All costs for these services shall be included in the contract price.

3-3. FIELD RUN TESTING. All pre-checks and preliminary tests will need to be completed and approved by the Design-Builder and manufacturer prior to performance testing.

Each blower shall be mechanically checked for proper operation. Each alarm and safety shutdown shall be checked by artificially simulating an alarm condition. Defective equipment and controls disclosed by the tests shall be replaced or corrected, and the packages placed in satisfactory operating condition. The following items shall be measured, recorded, and submitted in a field test report:

a. Discharge pressure, each blower.
b. Differential temperature across each blower unit.

c. Differential pressure across each intake filter unit.

d. Pressure and temperature at downstream end of piping system at any measurement taps provided.

e. Outdoor ambient temperature.

f. Indoor ambient temperature.

g. Barometric pressure.

3-4. TEST REPORTS. The equipment manufacturer shall prepare a test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder after completion of the specified tests.

3-5. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer's expense.

3-6. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-6.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-6.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

3-7. WARRANTY. All blowers shall be provided with a warranty as specified in the General Terms and Conditions. Blower manufacturers who do not have 5 years' operating experience with the specified blower type, as indicated by a reference list complete with contact information and installation dates, shall provide an extended warranty of 5 years.

End of Section

Section 43 11 17

ROTARY LOBE POSITIVE DISPLACEMENT BLOWERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of an electric motor, variable frequency driven, rotary, positive displacement blower packages to be installed as indicated on the Drawings and as required. The Design-Builder shall be responsible for providing the blower packages for the Sludge Holding Tanks.

Each blower package shall be a factory or shop fabricated skid and shall include blower, motor, inlet filter, inlet silencer, discharge silencer, belts, sheaves, belt guard, flexible connections, safety valve, discharge check valve, instrumentation, controls, and vibration isolators. The blower package shall be complete with all spare parts, accessories and appurtenances indicated on the Drawings, specified herein, or otherwise needed for proper operation.

Blower designation.	Sludge Holding Tank Blowers
Number of blowers.	2
Blower tag numbers.	71-AIR-BL-0001, 71-AIR-BL-0002
Blower location.	Residuals Area 70

Piping, pipe supports, some valves, and accessories for the equipment may be covered in other sections.

1-2. GENERAL.

1-2.01. Coordination. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, Engineering data, instructions, and recommendations furnished by the equipment manufacturer unless exceptions are noted by Design-Builder.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

The blower unit shall be a current standard product of the blower manufacturer and shall be a fully shop assembled package by one of the blower packagers specified in the data sheet. All accessory items shall be furnished by the blower packager.

The blower supplier shall be responsible for coordinating all components of the motor driven blowers including the variable frequency drives.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations Section, the requirements specified herein shall take precedence.

1-2.03. Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories (UL) safety requirements.

1-2.04. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.05. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1-2.06. Nameplates. The blower and accessory component having a tag number as indicated on the Drawings or specified herein, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Design-Builder. Permanent number plates shall be as specified in the Equipment and Valve Identification Section.

1-2.07. Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Lubricant type shall be as recommended by the equipment supplier.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures Section. Device tag numbers indicated on the Contract Drawings

shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for the unit shall include, but not be limited to the following:

Package

Letter from the blower manufacturer confirming blower package is fully shop assembled and will meet the performance requirements specified herein.

Dimensional drawings showing overall package dimensions, connection locations and sizes.

Package weight.

Blowers

Name of manufacturer.

Type and model.

Full rotative speed at rated condition.

Blower design maximum rotative speed.

Critical speed of the rotor.

Type of bearings, ABMA L_{10} life rating, and lubrication.

Connection sizes.

Maximum air temperature at discharge flange.

Maximum allowable forces and moments on blower inlet and discharge flanges.

Net weight of blower.

Net weight of heaviest single component requiring removal for maintenance.

Overall dimensions.

Complete performance curves or tables showing discharge pressure versus capacity and speed, blower and overall efficiency, and bhp at minimum and maximum ambient air temperatures and at standard conditions.

Reduced speed performance curve or tables for each 100 rpm increment at specified conditions including maximum, average, and minimum temperatures and corresponding relative humidities where variable frequency drives are required.

Shop painting data.

Anchor bolt location details.

Maximum estimated free field noise level at 3 feet.

Rubber cork pads isolators.

Motors

As specified in the Common Motor Requirement for Process Equipment.

Variable Frequency Drives

As specified in the Variable Frequency Drives Section.

Controls

Accessory device data including catalog cut sheets on all control components.

Accessories

Name of manufacturer.

Equipment data indicating overall dimensions, connection sizes, weights and materials of construction, pressure losses, efficiencies, and noise attenuation as applicable.

Drawing showing internal silencer baffling and construction.

Sound attenuation at each octave band for each silencer.

Drawing showing internal construction of each silencer.

Certified Shop Test Reports

Performance data.

Test data and results.

1-3.02. Operation and Maintenance Manuals. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures Section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures Section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions.

1-5. SPARE PARTS. The Supplier shall furnish all special tools and spare parts recommended by the manufacturers of equipment specified herein.

- Any special tools required for installation or maintenance of any of the furnished equipment shall be furnished.
- A complete itemized price list of all recommended special tools, spare parts, and consumables shall be submitted.
- A set of recommended spare parts and consumables for system startup and testing shall be furnished.

- A set of recommended spare parts and consumables for one year of operation from Date of Substantial Completion or Acceptance of Final Testing, whichever is later, shall be furnished.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Two dedicated blower packages consisting of two blowers shall provide mixing air to Sludge Holding Tanks 1 and 2.

The blower shall be suitable for the service conditions listed in the Meteorological and Seismic Design Criteria section and for the following service conditions:

Barometric pressure	14.6	psia
Design maximum inlet air temperature.	100	F
Design minimum inlet air temperature.	36	F
Design relative humidity at maximum design temperature.	40	%
Design relative humidity at average design temperature.	10	%

Parts shall be interchangeable between units of similar size and capacity to extent practical.

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Blower units shall be designed for the operating conditions as follows:

	Sludge Holding Tank System	
Blower tag numbers.	71-AIR-BL-0001, 71-AIR-BL-0002	
Operation.	Operation	
Discharge pipe connection.	Horizontal, low	
Maximum inlet pressure loss	0.4	psi
Inlet pressure at package suction flange.	14.2	psia
Rated discharge pressure at package outlet flange.	9.7	psig

	Sludge Holding Tank System	
Rated blower differential pressure.	10.1	psi
Minimum discharge pressure at package outlet flange (at low sludge tank level)	1.5	psig
Minimum capacity at rated package discharge pressure, maximum inlet air temperature and relative humidity and rated operating speed	320 (354)	scfm (inlet cfm)
Turndown capacity rated package discharge pressure, maximum inlet air temperature and relative humidity and rated operating speed	160	scfm
Ratio of maximum rated blower operating speed at normal motor speed to maximum allowable blower speed.	90	%
Ratio of rated discharge pressure at blower outlet flange to maximum allowable blower discharge pressure.	90	%
Maximum rated speed of motor.	3600	rpm
Maximum shaft power required at rated discharge pressure, minimum inlet temperature and relative humidity, and rated operating speed.	23.5	bhp
Maximum drive motor rating	25	hp
Intake Filter		
Equipment tag numbers.	N/A	
Maximum initial pressure drop.	2	in wc
Maximum face velocity at housing entrance.	100	ft/min
Filter configuration	Bottom-outlet Cartridge	

	Sludge Holding Tank System	
Filter element type.	Synthetic	
Particle arrestance (removal percentage/size).	99.97% for 1 micron and larger particles	
Minimum inlet and discharge silencer sound attenuation for blowers.		
Octave band 63.	17	dB
Octave band 125.	23	dB
Octave band 250.	27	dB
Octave band 500.	31	dB
Octave band 1000.	30	dB
Octave band 2000.	27	dB
Octave band 4000.	23	dB
Maximum discharge silencer operating temperature.	300	°F
Maximum estimated free field noise level with piped inlet and discharge connections at rated operating speed, measured 3 feet from any surface of acoustic enclosure.	85	dBA
Maximum overall vibration velocity of unpackaged blower at rated operating speed.	0.45	in/sec
Discharge Flexible Connection		
Discharge configuration	Horizontal	
Number of arches.	3	
Lateral spring rate	206	lbs/in
Axial spring rate	184	lbs/in
Lateral movement capabilities	3	in
Axial movement capabilities	2-5/8	in
Temperature rating.	300	°F

Standard cubic feet per minute, scfm, is defined as air at 14.7 psia, 68°F and 36 percent relative humidity. Blowers shall be capable of providing the specified mass flow in scfm throughout the entire operating range including at the specified summer conditions.

2-3. ACCEPTABLE MANUFACTURERS. Blowers shall be as manufactured by Aerzen, Atlas Copco, Gardner Denver Robuschi, or Kaeser and the blowers shall be packaged by Aerzen, Atlas Copco, Garden Denver, Kaeser, Universal Blower PAC, or Excelsior Blower Systems.

2-4. MATERIALS.

Casing and Impellers	Cast iron or ductile iron.
Shafts	High carbon steel or ductile iron; turned, ground and polished.
Timing Gears	Alloy steel.
Bearings	Antifriction, oil lubricated, ABMA rated L_{10} for 80,000 hours continuous operation.
Base	Fabricated steel.
Acoustical Enclosure	Galvanized steel, 14 gage thick, primed, with sound-absorbing material a minimum of 2” thick.

2-5. CONSTRUCTION.

2-5.01. Casings. Casings shall be designed to withstand at least twice the specified discharge pressure and shall be reinforced with integrally cast ribs. Each casing shall be provided with tapped and plugged openings for casing and bearing drains and fittings for properly adding bearing and gear lubricant.

2-5.02. Impellers. Impellers shall be reinforced by internal ribs and shall have all outside surfaces machined. The impeller shall be statically and dynamically balanced. Impellers shall be arranged for vertical air flow through the units unless otherwise indicated.

2-5.03. Shafts. Shafts shall be cast integrally with the impeller or shall pass completely through the impeller. Stub shafts will not be acceptable. Impellers shall be securely attached to through shafts.

2-5.04. Timing Gears. Timing gears shall be enclosed in oil tight housings.

2-5.05. Belts and Sheaves. All belts and blower and motor sheaves required for the blower shall be furnished. Belts and sheaves shall be of the heavy-duty "V" type with a horsepower rating of at least 1.2 times the motor nameplate horsepower.

2-5.06. Base Frame. A full length, common base shall be provided for the blower package. The base frames shall be constructed of cast iron or heavy steel plate and structural members and shall be designed for no measurable deflection with the equipment mounted thereon and the base frame supported from the floor. The base shall be designed so that all equipment bolted to it can be removed without access to the underside, and for ease of cleaning. Structural stiffeners shall be located under the equipment at the equipment anchor points. A drip lip will not be required. The base shall be suitable for direct attachment to the foundation. Complete support of the inlet and discharge silencers shall be from the base frame. The blower supplier shall provide and install silencer supports for the blower package. The inlet filter shall be attached to the inlet silencer.

2-5.07. Silencers. The blower shall be furnished with a silencer in the suction and discharge piping. Silencers shall be multi-chambered reactive type or combination multi-chambered reactive/absorptive type as required by the blower operating speed. Silencers shall be equipped with ported tubes and air passageways to reduce blower pulsations and system air noise from the blower. There shall be no “line of sight” passages within the silencer design. Each silencer shall be of all-welded steel construction with painted exterior surfaces and flanged connections with diameter and drilling conforming to ASME B16.1, Class 125.

If the specified 3-lobe blower vendor does not offer the type of silencers specified in their package, the following paragraph shall apply.

If resonance in the piping occurs, an independent consultant shall be contracted to analyze the noise. If the resonance is the result of pulsations emanating from the blower package, then the blower packager will be liable for the charges relating to the acoustical analysis and correction of the problem. Correction of the problem will likely involve installation of additional silencers. Additional silencers shall be installed as close to the blower package as possible to prevent resonant piping lengths. The blower shall be initially sized with sufficient additional pressure capability to compensate for the losses through additional silencers in case they are required. Additional silencers shall be as specified herein with low frequency sound attenuation capability.

2-5.08. Acoustical Enclosure. The acoustic enclosure shall be a self-supporting structure housing at least the blower, motor and drive mounted on the package skid base. There shall not be pipe extensions on the skid made to accommodate the sound enclosure. The enclosure shall be constructed of panels consisting of noise dampening material sandwiched between two metal sheets if the dampening material is friable. If the material not friable, the interior sheet may be omitted. The enclosure shall be provided with removable panels or hinged sections to allow routine blower and V-belt maintenance. The maximum weight

required to be lifted for removal/opening the access openings shall not exceed 50 lbs.

All bracing and reinforcing members shall be integral to the enclosure. Air piping shall be piped to outside of the enclosure and terminate with a pipe flange. The flanges shall be ASME B16.1, Class 125 diameter and drilling and shall extend not less than 4 inches outside of the enclosure for flange bolt removal.

An internal ventilating system shall be provided for the enclosure. The ventilation system shall utilize a 120 volt ac rated electric motor driven ventilating fan to draw ambient air into the enclosure for cooling the enclosed equipment prior to exhausting the air outside of the enclosure. Air inlet and exhaust openings shall have noise abatement features that meet the maximum noise level specified when the ventilating system and blower are operating simultaneously. The ventilating fan shall be powered and controlled through the blower control panel. A timer shall be provided to allow the fan to continue to operate for an adjustable time period after the blower shuts down. When installed outdoors, the ventilation inlet and exhaust openings shall be designed to prevent rain/snow penetration during operation at the maximum wind speeds specified.

2-5.09. Anchor Bolts. Anchor bolts shall be per the General Equipment Stipulations and the Anchorage in Concrete and Masonry section.

2-6. ACCESSORIES.

2-6.01. Intake Filter. Each blower shall be provided with an intake filter. Each filter shall have a replaceable synthetic, pleated filter element, and flanged outlet connection. Filter shall be cartridge type. Filter silencer shall be suitable for continuous weather exposure in exterior locations.

Filter silencer shall be installed such that the outside air inlet of the filter unit shall be a minimum of 3 feet above the adjacent grade or roof. The filter shall connect to the suction piping without reducers. Additionally each inlet filter shall be provided with differential pressure switches to shut down the blower on high differential pressure across the inlet filter (dirty filter).

Filter shall be Endustra.

2-6.02. Blowoff Silencers. Not used.

2-6.03. Vibration Isolator Base Pads. Vibration mount isolators shall be supplied with the blower package.

2-6.04. Flexible Connections. An elastomeric, flanged, arched type flexible connection shall be provided in the discharge piping adjacent to the blower as specified herein.

The flexible connection shall be sized to allow piping movement without exceeding the blower manufacturer's force allowance at the blower flange. Minimum piping movements allowed for each discharge flexible connection shall be as specified herein. The number of arches shall be as specified herein or as needed to meet the specified spring rates and movement capabilities. The inlet connection shall be suitable for 7 psi vacuum service and the discharge connection shall be suitable for a pressure of 15 psig and a temperature rating of 300°F. Suction flexible connectors shall be single arch, Mercer “Type 450,” or equal. Discharge flexible connectors shall be Mercer “Type 450” with “Type 500” retaining rings and Kevlar reinforcement, or equal, with the number of arches, spring rate, and movement as indicated herein.

2-6.05. Valves.

2-6.05.01. Safety Valves. The blower shall be provided with a safety valve, or pressure relief valave, as recommended by the blower manufacturer. The safety valves shall be capable of protecting the blowers from damage due to operation with a closed discharge valve. Safety valves shall be suitable for temperature up to 300°F. Set points shall be at least 1 psi above the rated blower discharge pressure unless otherwise indicated.

Weighted type safety valves shall be anodized aluminum, as manufactured by Pathfinder Systems, Inc. without exception. Weights shall be chrome zinc plated and provided in half pound increments for settings below 15 psig.

2-6.05.02. Check Valves. An air check valve shall be installed in the discharge piping from the blower downstream of the discharge silencer as part of the factory piped package. See the Check Valve section (40 05 68). See the Check Valve section.

2-6.06. Pressure Gauges. A pressure gauge shall be furnished and installed in the discharge piping of the blower and a vacuum gauge in the suction piping of the blower.

Pressure gauges shall conform to ANSI B40.1 and shall be of the indicating dial type with C-type phosphor bronze bourdon tube, stainless steel rotary geared movement, phenolic open front turret case, adjustable pointer, stainless steel or phenolic ring, and acrylic plastic or shatterproof glass window. All gauges shall be ANSI Accuracy Grade A. Gauges installed indoors shall be liquid filled.

The dial shall be a minimum 2-1/2 inch size with white background and black markings and shall have dual English and metric indication. The English units of measurement shall be pounds per square inch and the metric units shall be kilopascals. The range for each discharge pressure gauge shall be from

0 to 15 psig. The range for each vacuum gauge shall be from 15 inches Hg vacuum to 0. Pointer travel shall be not less than 200 degrees nor more than 270 degrees.

All gauges shall be provided with 1/2 inch NPT connections. Each gauge shall be provided with a threaded end ball type shutoff valve as specified in the Miscellaneous Ball Valves section installed at the blower discharge piping connection.

2-6.07. Pressure Switch. A pressure switch shall be furnished and installed in the discharge piping of the blower and furnished for installation across each intake filter. Each switch in the blower discharge piping shall have an adjustable range of 0 to 15 psig and shall be set lower than the relief valve setting. Each switch across the intake filters shall have an adjustable range from 0 to 10 inches water column vacuum.

Each pressure switch shall be field adjustable and shall have a trip point repeatability of better than 1 percent of actual pressure. Each switch shall have one normally open and one normally closed contact rated 10 amps at 120 volt ac. Each switch shall be wired to the blower control panel and shall shut down the blower on high discharge pressure or high pressure drop across the filter. Switches shall have a weatherproof housing and shall be as manufactured by Static-O-Ring Company, Mercoid Control, Barksdale, or equal.

2-6.08. Draft Gauge. A draft gauge shall be provided having a range from 0 to 10 inches water column shall be installed across each air filter or air filter silencer.

The gauge shall have minimum 3-1/2 inch dial, pressure taps, fittings for 1/4 inch metal tubing, vent valves, mounting brackets, and an adjustable signal flag.

The draft gauge shall be "Dwyer 2000 Series Magnehelic Differential Pressure Gages" manufactured by Dwyer Instruments, Inc., or equal.

2-6.09. Thermometers. A thermometer shall be provided for monitoring of temperature in the discharge piping. The thermometer shall be mounted on the blower control panel. The capillary routing shall not require disassembly for normal maintenance of the blower, motor or V-belts.

Thermometers shall be of the remote reading gas actuated dial type. Thermometers shall have a minimum dial size of 5 inches, an adjustable pointer, shall be accurate within 1 percent of full scale. Thermometers shall have both Fahrenheit and Celsius indication. Thermometers shall be furnished complete with a uniformly graduated dial indicator, armored capillary tube, bulb or temperature sensor, and thermowell. Thermometer ranges shall be such that the normal operating reading will be near the midpoint of the range. The units of

measurement shall be indicated on the dial face. Spare capillary length shall be neatly coiled and tied.

2-6.10. Temperature Switches. Temperature switches shall be remote bulb type with one normally open and one normally closed contact rated 10 amps at 120 volt ac. Temperature switches shall have NEMA 4X housings, Type 316 stainless steel thermal well assemblies, and armored capillaries. Capillary length shall be sufficient for convenient mounting. Each temperature switch shall be wired to the blower control panel and shall shut down the corresponding blower on high discharge air temperature.

2-6.11. Vibration Detection Systems. Not used.

2-7. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibrations shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the maximum unfiltered vibration velocity, as measured at any point on the machine, shall be as required.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8.

2-8. DRIVE UNITS. The blower shall be driven by an electric motor through either a direct drive or belt drive as required. Drive units shall be designed for 24 hour continuous service.

2-8.01. V-Belt Drives. The V-belt drive shall include a sliding base or other suitable tension adjustment.

2-8.02. Safety Guards. All belt drives, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.

2-8.03. Variable Frequency Drive. A variable frequency drive (VFD) shall be provided for the blower package by others. Variable frequency drives shall be as specified in the Variable Frequency Drives Section. The blower supplier shall coordinate with the motor and VFD manufacturers and be responsible for providing a motor and VFD which produces sufficient torque above the blower load curve to assure proper acceleration under all operating conditions. The blower supplier shall also coordinate with the motor and VFD manufacturers and be responsible for providing a motor with component mass and spring constant

such that torsional resonant frequencies do not occur in the system under all accelerating and normal operating conditions. The blower supplier shall also coordinate with the motor manufacturer and be responsible for providing a motor of adequate thermal design for the system inertia and load to permit one start per hour at rated temperature rise and two successive starts at 40 degrees C ambient without exceeding the motor insulation and component temperature limits.

2-9. CONTROLS.

2-9.01. Blower Motor Starters. Not used.

2-9.02. Blower Control Panel. Each blower shall be furnished with a local blower control panel. The power supply to the blower control panel shall be 120 volt, 60 hertz, single phase. The blower control panel shall be furnished with a main circuit breaker disconnect with a lockable operating handle on the exterior of the panel. The blower control panel shall be furnished with all control power transformers, gauges, relays, pilot devices, indicators, etc., required to monitor, protect and shut down its respective blower.

The control panel shall be furnished with a Local-Off/Reset-Remote selector switch for each blower. The switch shall be lockable in the center Off/Reset position. In the Local position the blower shall run and blower speed shall be set manually at the blower control panel. In the Off/Reset position the blower shall stop and reset any equipment protection/alarm conditions. In the Remote position the control panel shall accept a normally open relay contact for blower start and stop control and a 4-20mA blower speed control signal from PLC. The selector switch shall be furnished with a contact for remote indication of Remote position.

The control panel shall be mounted separate from the blower package to prevent vibration from affecting panel mounted components, as shown on the drawings. All components installed in or on the panel shall be rated for the control power supply as required. If voltages other than the specified control power supply is required, the panel supplier shall furnish the required control power transformers.

The control panel shall be furnished with a white control power on indicating light, a green blower stopped indicating light and a red blower running indicating light.

The control panel shall be furnished with amber indicating alarm lights for high differential air temperature across the blower, high discharge pressure, high differential pressure across intake filter, and motor/AFD overload/fail.

Indicating lights shall be provided for each blower.

In lieu of the lights indicated, all items may be provided on a touch screen rather than indicated by lights if preferred by the vendor. Touch screen shall be rated for 163F.

For all conditions above requiring amber indicating lights an alarm relay shall be furnished with two normally open contacts rated 10 amperes at 120 volt ac. The normally open contacts shall close for any alarm condition and shall be used for remote annunciation of a blower alarm and shall shut down the blower.

The blower control panel shall be furnished with a normally open dry run contact rated 10 amperes at 120 volts ac for remote indication of blower running.

The panel shall be furnished with a warning and alarm light test pushbutton that illuminates all panel mounted lights when pushed. The panel shall be provided with an elapsed time hour meter for displaying the running time of each blower. The panel shall be provided with an emergency stop button.

2-9.03. Panel Fabrication Requirements. The control panel furnished shall conform to the requirements of NEMA ICS-6. Panels shall be rated NEMA Type 4X and shall be constructed from stainless steel.

All panel wiring shall be of the type normally furnished by the manufacturer with the following exceptions. All power and control wiring for 120 volt circuits shall be stranded copper #12 AWG minimum. All power and control wiring shall have a 600 volt insulation rating and a nominal maximum operating temperature of 90 degrees C. All analog circuits shall be #16 AWG twisted shielded pair rated for at least 300 volts. Conductor insulation for power, control, and analog circuits shall have a moisture-resistant and flame-retardant covering.

All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and with space equal to at least 40 percent of the depth of the duct remaining available for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal clamping voltage of 200 volts. Surge protectors shall be of nonfaulting and noninterrupting design, with a response time not to exceed 5 nanoseconds. Surge protectors shall be manufactured by Innovative Technology, Power Integrity Corporation, or Transtector.

Terminal blocks shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strips, covers, and pressure connectors. Terminals shall be labeled to agree with the identification on the System Supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. At least 25 percent spare terminals shall be provided. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Nameplates shall be provided on the face of each panel and on each individual control or pilot device. Panel nameplates shall be made of laminated phenolic material with engraved letters approximately 3/16 inch high extending through the black face into the white layer, and shall be secured firmly to the panel.

All control and pilot devices furnished shall be NEMA 4 rated, heavy duty oiltight.

2-9.04. Factory Panel Test. Before shipment, the panels shall be electrically tested by the manufacturer.

2-10. SHOP PAINTING. Equipment and items furnished as specified herein shall be furnished with shop coatings suitable for permanent installation and operation in accordance with the requirements in the General Equipment Stipulations section.

2-11. SHOP TESTS.

2-11.01. Operational Test. The blower shall be shop tested by the manufacturer for vibration and pressure developed and shall be checked for leaks, faulty components and controls.

2-11.02. Slip Test. A one psi slip test shall be performed on the blower. The test shall consist of an ASME PTC-9 slip test, with calculations correcting the results to field conditions, to ensure compliance with specifications. The test shall be in accordance to the paragraph, 4.52 of ASME PTC-9 slip test. Testing in accordance with ISO 1217 is an acceptable alternative.

2-11.03. Performance Test. Not required.

2-11.04. Vibration Test. A vibration test shall be performed on the blower. When the vibration test indicates an overall vibration velocity greater than 0.45 inches per second, the manufacturer shall be responsible for performing and reviewing a frequency analysis. The manufacturer shall make corrections as necessary, and confirm that the vibration velocity will not be detrimental to the equipment. An overall vibration velocity greater than 1.0 inch per second shall be sufficient cause for rejection of the equipment.

Defective equipment and controls disclosed by the tests shall be replaced and each unit placed in satisfactory operating condition before shipping.

A PDF of the test report complete with performance curves, data, and all calculations shall be submitted to the Design-Builder in accordance with the Submittals Procedures Section.

PART 3 - EXECUTION

3-1. INSTALLATION. Each unit shall be installed in accordance with Equipment Installation section and as specified herein.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily and in accordance with the specified performance requirements.

The manufacturer’s representative shall verify:

a. Each blower discharge isolation valve is fully open.
b. Each check valve is properly installed.
c. Piping is installed such that excessive force is not being exerted on the blower flanges.
d. No resonance vibration conditions are occurring within the blower package or air piping.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. FIELD RUN TESTING. All pre-checks and preliminary tests will need to be completed and approved by the Design-Builder and manufacturer prior to performance testing.

Each blower shall be mechanically checked for proper operation. Each alarm and safety shutdown shall be checked by artificially simulating an alarm condition. Defective equipment and controls disclosed by the tests shall be replaced or corrected, and the packages placed in satisfactory operating condition. The following items shall be measured, recorded, and submitted in a field test report:

a. Discharge pressure, the blower.
b. Discharge temperature, the blower.
c. Differential pressure across each intake filter unit.
d. Pressure and temperature at downstream end of piping system at any measurement taps provided.
e. Flow measurements at any flow meters provided.
e. Outdoor ambient temperature.
f. Indoor ambient temperature.
g. Barometric pressure.

3-4. TEST REPORTS. The equipment manufacturer shall prepare a test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder after completion of the specified tests.

3-5. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer’s expense.

3-6. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-6.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-6.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 43 23 13.14

HORIZONTAL END SUCTION CENTRIFUGAL PUMPS – IPR

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of single-stage, horizontal, end suction centrifugal pumping units as required.

Pump designation.	IPR Pump
Number of pumps.	3 (2 duty/1 standby)
Pump tag numbers.	63-TW-P-0101, 63-TW-P-0201, 63-TW-P-0301
Pump location.	IPR Product Water Pump Station Area 63

Each pumping unit shall be complete with a pump, electric motor, anchor bolts, and other appurtenances specified or otherwise required for proper operation, all mounted on a common baseplate. Pumps of the close-coupled type, with the impeller attached directly to the motor shaft without pump bearings or flexible couplings, will not be acceptable.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1-2.04. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.05. Identification. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps

Name of manufacturer.
Type and model.
Tag number.
Pump location.
Rotative speed.
Size of suction nozzle.
Size of discharge nozzle.
Net weight of pump only.
Net weight with baseplate and coupling.
Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire-to-water efficiency, and pump input power.
Data of coupling.
Data on shop painting.
Base and anchor bolt details.

Motors

As specified in the Common Motor Requirements for Process Equipment section.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instruction or parts lists packed with or attached to the equipment when delivered.

1-4. QUALITY ASSURANCE.

1-4.01. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including the motor, shall not exceed the maximum vibration limits of the governing standard unless otherwise required.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1-5. SPARE PARTS. The Design-Builder shall provide spare parts per the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The IPR pumps convey recycled water to injection wells located in the Morro Valley via the IPR Product Water Transmission Main (by others).

The pumping units shall be suitable for operation in accordance with the Meteorological and Seismic Design Criteria section and for the following service conditions:

Seismic design requirements.	See Meteorological and Seismic Design Criteria section
Type of environmental exposure.	Outdoor (open)
Pumps start and stop against a closed valve.	Yes

Parts shall be interchangeable between units of similar size and capacity to extent practical.

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Pumping units shall be designed for the operating conditions as follows:

Pump Names	IPR Pumps	
Pump tag numbers.	63-TW-P-0101, 63-TW-P-0201, 63-TW-P-0301	
Rated head.	37	ft
Capacity at rated head.	323	gpm
Operating head range for full speed continuous operation.	26 to 45	ft
Minimum shutoff head.	70	ft
Maximum nominal pump speed.	1800	rpm
Minimum head at reduced speed.	40	ft
Capacity at minimum head at reduced speed.	167	gpm
Approximate minimum pump speed, percent of maximum.	50	%
Maximum power required at pump input shaft at any point minimum operating head to shutoff head.	7.5	bhp
Efficiency.	74	%
Type of efficiency indicated.	Pump	
Efficiency calculated at.	Rated head	
Pump designed for reverse rotation.	No	
Minimum NPSHA at rated head.	32	ft
Minimum NPSHA at minimum operating head.	48	ft
Maximum suction pressure.	7	psi
Maximum “A” rated weighted noise at 3 ft.	80	dBa
Maximum unfiltered vibration velocity.	HIS	
Pump rotation as viewed from driven end.	Clockwise	
Minimum pump suction nozzle size.	4	in
Minimum pump discharge nozzle size.	3	in

Pump Names	IPR Pumps	
Pump tag numbers.	63-TW-P-0101,	
	63-TW-P-0201,	
	63-TW-P-0301	
Minimum test sphere diameter.	0.25	in

All specified conditions shall be at rated speed unless otherwise indicated.

The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus maximum suction pressure.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction submergences. The design performance shall be based on a wearing ring diametral clearance of not less than 1 mil per inch of wearing ring diameter, or 12 mils total, whichever is greater.

2-3. MATERIALS. Each pump shall be constructed of the following materials as required.

Frame	Cast iron, ASTM A48.
Casing and Casing Covers	Cast iron, ASTM A48.
Casing Wearing Ring	Bronze, ASTM B505-952.
Impeller	Bronze, ASTM B62.
Impeller Wearing Ring	Bronze, ASTM B505-952.
Shaft	Carbon steel, AISI 1045.
Stuffing Box Hardware	Corrosion-resistant metal.
Packing	Braided, graphited or teflon impregnated Kevlar.
Lantern Ring	Bronze or glass-filled teflon for 2-1/2 inch OD and smaller shafts; bronze only for shafts larger than 2-1/2 inches.
Shaft Sleeve (w/packing)	Bronze, ASTM B505-954.

Flexible Coupling	Resilient type; Falk “Steelflex” or Woods “Sure-Flex”.
Bearings	Antifriction.
Baseplate	Cast iron or fabricated steel.

2-4. PUMP CONSTRUCTION.

2-4.01. Casing Assembly. The casing assembly and drive connection shall permit the removal of the rotating element without disconnecting the piping. Casing parts shall have registered fit to maintain alignment. The nozzle flanges shall be flat faced, with ANSI/ASME B16.1, Class 125 diameter and drilling.

Pipe-tapped openings shall be provided for draining, priming, and venting the casing, except where Ni-hard or high-chrome cast iron casings are specified.

Cast iron casings shall be provided with plugged gauge cock connections on the suction and discharge nozzles.

2-4.02. Impeller. The impeller shall be a one-piece casting. The impeller shall be completely machined on all exterior surfaces, except when high chrome alloy material is specified. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be securely locked to the shaft so that it will not be loosened by reverse rotation, but shall be easily removable.

Type of impeller.	Enclosed.
Impeller balancing.	Dynamic.
Impeller to shaft attachment.	Keyed or Threaded.
Maximum number of impeller ports.	Single.

2-4.03. Shaft and Shaft Sleeves. The shaft shall be completely machined. Deflection at the stuffing box shall not exceed 0.002 inch at any head in the operating range. A suitable splash deflector shall be mounted on the shaft adjacent to the frame bearing housing.

The shaft shall be provided with a replaceable sleeve extending from the impeller through the stuffing box. The sleeve shall be positively secured to the shaft and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly on the shaft, total runout shall not exceed 0.002 inch.

2-4.04. Wearing Rings. Renewable wearing rings shall be provided in the casing and on the impeller. The rings shall be positively locked in place.

2-4.05. Stuffing Box. The stuffing box for each pumping unit shall contain a split lantern ring at least as wide as two packing rings, at least five packing rings, and split glands at the outboard end. The gland halves shall be interlocked at assembly and held in position at all pressures by at least two bolts or studs. Each box shall be tapped at the normal lantern ring position and provided with a suitable fitting for either a grease zerk for grease lubrication of the packing.

2-4.06. Seal Water Station. Not used.

2-4.07. Frame Assembly. The frame assembly shall rigidly support the rotating element with two bearings. The outboard bearing shall carry both axial and radial pump loads. If wearing clearance is axial, the assembly design shall permit axial adjustment of the rotor without dismantling the pump. Bearing enclosures shall keep out contaminants and retain the lubricant and shall have adequate provisions for adding and draining lubricant.

The frame shall provide ample clearance for stuffing box maintenance.

2-4.08. Bearings. Bearings shall be either oil or grease lubricated, antifriction type. Bearings shall have an ABMA L_{10} Life Rating of 40,000 hours at specified operating conditions. The pump shaft speed shall not exceed the limits specified by the bearing manufacturer.

2-4.09. Equipment Bases. Baseplates for pumps of at least 60 hp shall provide for tapered dowels to maintain alignment of pump and motor. Other requirements for equipment bases are specified in the General Equipment Stipulations.

2-5. ACCESSORIES. Each pump shall be provided with lifting eyebolts or lugs; tapped and plugged openings for casing assembly and bearing housing vents and drains; and appropriate fittings for adding bearing lubricant and seal water. Grease lubricated pumping units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2-6. DRIVE UNITS. Each pump shall be driven by an electric motor through a flexible coupling. Drive units shall be designed for 24 hour continuous service. Gearmotors shall not be used.

2-6.01. Belt Drives. Not used.

2-6.02. Couplings. Couplings shall have a horsepower rating 1.25 times the motor nameplate horsepower when the misalignment is within the manufacturer's

tolerance limit. Coupling design shall permit removal of the pump rotating element without disconnecting the piping, moving the drive unit, or axial movement of the coupling halves on the shaft. The coupling shall be resilient type.

2-6.03. Electric Motors. The electric motors shall be designed as specified in the Common Motor Requirements for Process Equipment section.

2-6.04. Variable Frequency Drives. Not used.

2-7. SHOP TESTS. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, evaluated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall be made in conformity with the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be per Table 14.6.3.4 Grade 1U, with no minus tolerance or margin allowed.

For pumping units under 100 horsepower, a certified performance curve including head, pump input power, pump efficiency, and wire-to-water efficiency (when specified) shall be prepared by the pump manufacturer. A PDF copy of the certified curve shall be submitted to Design-Building not less than 10 days prior to the shipment of the equipment from the factory.

PART 3 - EXECUTION

3-1. INSTALLATION. Each pumping unit shall be installed in accordance with the Hydraulic Institute Standards, the Equipment Installation section, and as specified herein.

The equipment base shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, connections to pumping equipment shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

Couplings shall be realigned after grouting. Final coupling misalignment shall be within one-half of the coupling manufacturer's allowable tolerance.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect,

check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-3.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-3.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 43 23 13.14 – Outfall Pumps

HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of single-stage, horizontal, end suction centrifugal pumping units as required.

Pump designation.	Outfall Pump (Large)	Outfall Pump (Small)
Number of pumps.	2	2
Pump tag numbers.	64-TW-P-0101, 64-TW-P-0201	64-TW-P-0301, 61-TW-P-0401
Pump location.	Outfall Pump Station Area 64	Outfall Pump Station Area 64

Each pumping unit shall be complete with a pump, electric motor, anchor bolts, and other appurtenances specified or otherwise required for proper operation, all mounted on a common baseplate. Pumps of the close-coupled type, with the impeller attached directly to the motor shaft without pump bearings or flexible couplings, will not be acceptable.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1-2.04. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.05. Identification. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps

Name of manufacturer.
Type and model.
Tag number.
Pump location.
Rotative speed.
Size of suction nozzle.
Size of discharge nozzle.
Net weight of pump only.
Net weight with baseplate and coupling.
Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire-to-water efficiency, and pump input power.
Data of coupling.
Data on shop painting.
Base and anchor bolt details.

Motors

As specified in the Common Motor Requirements for Process Equipment section.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instruction or parts lists packed with or attached to the equipment when delivered.

1-4. QUALITY ASSURANCE.

1-4.01. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including the motor, shall not exceed the maximum vibration limits of the governing standard unless otherwise required.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1-5. SPARE PARTS. The Design-Builder shall provide spare parts per the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The Outfall pumps take flow from the Outfall Balancing Tank and send the treated WRF effluent to the ocean outfall. The Outfall Balancing Tank is a collection point for MBR Filtrate and during large events, blended with primary treated wastewater, RO and / or UV bypass water.

The pumping units shall be suitable for the following service conditions:

Seismic design requirements.	See Meteorological and Seismic Design Criteria section
Type of environmental exposure.	Outdoor (open)
Pumps start and stop against a closed valve.	No

Parts shall be interchangeable between units of similar size and capacity to extent practical.

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Pumping units shall be designed for the operating conditions as follows:

Pump tag numbers.	64-TW-P-0101, 64-TW-P-0201	64-TW-P-0301, 64-TW-P-0401	
Rated head.	68	68	ft
Capacity at rated head.	2840	1460	gpm
Operating head range for full speed continuous operation.	26 to 79	22 to 52	ft
Minimum shutoff head.	95	90	ft
Maximum nominal pump speed.	1800	1800	rpm
Minimum head at reduced speed.	44	41	ft
Capacity at minimum head at reduced speed.	1420	200	gpm
Approximate minimum pump speed, percent of maximum.	50%	50	%
Maximum power required at pump input shaft at any point minimum operating head to shutoff head.	63	31	hp
Efficiency.	80%	68	%
Type of efficiency indicated.	Pump	Pump	
Efficiency calculated at.	Rated head	Rated head	
Pump designed for reverse rotation.	No	No	
Minimum NPSHA at rated head.	30	30	ft
Minimum NPSHA at minimum operating head.	46	46	ft
Maximum suction pressure.	7	7	psi
Maximum “A” rated weighted noise at 3 ft.	85	85	dBa

Pump tag numbers.	64-TW-P-0101, 64-TW-P-0201	64-TW-P-0301, 64-TW-P-0401	
Maximum unfiltered vibration velocity.	HIS	HIS	
Pump rotation as viewed from driven end.	Clockwise	Clockwise	
Minimum pump suction nozzle size.	10	8	in
Minimum pump discharge nozzle size.	8	6	in
Minimum test sphere diameter.	2	2	in

All specified conditions shall be at rated speed unless otherwise indicated.

The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus maximum suction pressure.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction submergences. The design performance shall be based on a wearing ring diametral clearance of not less than 1 mil per inch of wearing ring diameter, or 12 mils total, whichever is greater.

2-3. MATERIALS. Each pump shall be constructed of the following materials as required.

Frame	Cast iron, ASTM A48.
Casing and Casing Covers	Cast iron, ASTM A48.
Casing Wearing Ring	Bronze, ASTM B505-952.
Impeller	Bronze, ASTM B62.
Impeller Wearing Ring	Bronze, ASTM B505-952.
Shaft	Carbon steel, AISI 1045.
Stuffing Box Hardware	Corrosion-resistant metal.

Packing	Braided, graphited or teflon impregnated Kevlar.
Lantern Ring	Bronze or glass-filled teflon for 2-1/2 inch OD and smaller shafts; bronze only for shafts larger than 2-1/2 inches.
Shaft Sleeve (w/packing)	Bronze, ASTM B505-954.
Flexible Coupling	Resilient type; Falk "Steelflex" or Woods "Sure-Flex".
Bearings	Antifriction.
Baseplate	Cast iron or fabricated steel.

2-4. PUMP CONSTRUCTION.

2-4.01. Casing Assembly. The casing assembly and drive connection shall permit the removal of the rotating element without disconnecting the piping. Casing parts shall have registered fit to maintain alignment. The nozzle flanges shall be flat faced, with ANSI/ASME B16.1, Class 125 diameter and drilling.

Pipe-tapped openings shall be provided for draining, priming, and venting the casing, except where Ni-hard or high-chrome cast iron casings are specified.

Cast iron casings shall be provided with plugged gauge cock connections on the suction and discharge nozzles.

2-4.02. Impeller. The impeller shall be a one-piece casting. The impeller shall be completely machined on all exterior surfaces, except when high chrome alloy material is specified. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be securely locked to the shaft so that it will not be loosened by reverse rotation, but shall be easily removable.

Type of impeller.	Enclosed.
Impeller balancing.	Dynamic.
Impeller to shaft attachment.	Keyed or Threaded.
Maximum number of impeller ports.	Single.

2-4.03. Shaft and Shaft Sleeves. The shaft shall be completely machined. Deflection at the stuffing box shall not exceed 0.002 inch at any head in the

operating range. A suitable splash deflector shall be mounted on the shaft adjacent to the frame bearing housing.

The shaft shall be provided with a replaceable sleeve extending from the impeller through the stuffing box. The sleeve shall be positively secured to the shaft and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly on the shaft, total runout shall not exceed 0.002 inch.

2-4.04. Wearing Rings. Renewable wearing rings shall be provided in the casing and on the impeller. The rings shall be positively locked in place.

2-4.05. Stuffing Box. The stuffing box for each pumping unit shall contain a split lantern ring at least as wide as two packing rings, at least five packing rings, and split glands at the outboard end. The gland halves shall be interlocked at assembly and held in position at all pressures by at least two bolts or studs. Each box shall be tapped at the normal lantern ring position and provided with a suitable fitting for either a grease zerk for grease lubrication of the packing.

2-4.06. Seal Water Station. Not used.

2-4.07. Frame Assembly. The frame assembly shall rigidly support the rotating element with two bearings. The outboard bearing shall carry both axial and radial pump loads. If wearing clearance is axial, the assembly design shall permit axial adjustment of the rotor without dismantling the pump. Bearing enclosures shall keep out contaminants and retain the lubricant and shall have adequate provisions for adding and draining lubricant.

The frame shall provide ample clearance for stuffing box maintenance.

2-4.08. Bearings. Bearings shall be either oil or grease lubricated, antifriction type. Bearings shall have an ABMA L_{10} Life Rating of 40,000 hours at specified operating conditions. The pump shaft speed shall not exceed the limits specified by the bearing manufacturer.

2-4.09. Equipment Bases. Baseplates for pumps of at least 60 hp shall provide for tapered dowels to maintain alignment of pump and motor. Other requirements for equipment bases are specified in the General Equipment Stipulations.

2-5. ACCESSORIES. Each pump shall be provided with lifting eyebolts or lugs; tapped and plugged openings for casing assembly and bearing housing vents and drains; and appropriate fittings for adding bearing lubricant and seal water. Grease lubricated pumping units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2-6. DRIVE UNITS. Each pump shall be driven by an electric motor through a flexible coupling. Drive units shall be designed for 24 hour continuous service. Gearmotors shall not be used.

2-6.01. Belt Drives. Not used.

2-6.02. Couplings. Couplings shall have a horsepower rating 1.25 times the motor nameplate horsepower when the misalignment is within the manufacturer's tolerance limit. Coupling design shall permit removal of the pump rotating element without disconnecting the piping, moving the drive unit, or axial movement of the coupling halves on the shaft. The coupling shall be resilient type.

2-6.03. Electric Motors. The electric motors shall be designed as specified in the Common Motor Requirements for Process Equipment section.

2-6.04. Variable Frequency Drives. Not used.

2-7. SHOP TESTS. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, evaluated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall be made in conformity with the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be per Table 14.6.3.4 Grade 1U, with no minus tolerance or margin allowed.

For pumping units under 100 horsepower, a certified performance curve including head, pump input power, pump efficiency, and wire-to-water efficiency (when specified) shall be prepared by the pump manufacturer. Five copies of the certified curve shall be delivered to Design-Builder not less than 10 days prior to the shipment of the equipment from the factory.

PART 3 - EXECUTION

3-1. INSTALLATION. Each pumping unit shall be installed in accordance with the Hydraulic Institute Standards, the Equipment Installation section, and as specified herein.

The equipment base shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, connections to pumping equipment shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

Couplings shall be realigned after grouting. Final coupling misalignment shall be within one-half of the coupling manufacturer's allowable tolerance.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-3.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-3.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 43 23 13.14 – SAFE Filter

HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of single-stage, horizontal, end suction centrifugal pumping units for the Cloth Disk Filter (SAFE Filter). These pumps shall be provided by the Cloth Disk Filter Supplier.

Pump designation.	Filter Backwash Waste, Filter Solids Waste Pumps
Number of pumps.	2
Pump tag numbers.	73-FSW-P-0001, 73-FSW-P-0002
Pump location.	SAFE Filter Area 73

Each pumping unit shall be complete with a pump, electric motor, variable frequency drive, anchor bolts, and other appurtenances specified or otherwise required for proper operation, all mounted on a common baseplate. Pumps of the close-coupled type, with the impeller attached directly to the motor shaft without pump bearings or flexible couplings, will not be acceptable.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-builder. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1-2.04. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.05. Identification. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps
- Name of manufacturer.
- Type and model.
- Tag number.
- Pump location.
- Rotative speed.
- Size of suction nozzle.
- Size of discharge nozzle.
- Net weight of pump only.
- Net weight with baseplate and coupling.
- Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire-to-water efficiency, and pump input power.
- Data of coupling.
- Data on shop painting.
- Base and anchor bolt details.

Motors
- As specified in the Common Motor Requirements for Process Equipment section.

Variable Frequency Drives
- As specified in the Variable Frequency Drives section.

Seismic Design Requirements
- Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instruction or parts lists packed with or attached to the equipment when delivered.

1-4. QUALITY ASSURANCE.

1-4.01. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including the motor, shall not exceed the maximum vibration limits of the governing standard unless otherwise required.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1-5. SPARE PARTS. The manufacturer shall provide spare parts per the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The SAFE Filter Backwash Waste pumps backwash the disks. The Solids Waste pumps drain the tank and remove solids from the SAFE Filter system and return the flows to the Sludge Holding Tanks.

The pumping units shall be suitable for operation in accordance with the Meteorological and Seismic Design Criteria section and for the following service conditions:

Seismic design requirements.	See Meteorological and Seismic Design Criteria section
Type of environmental exposure.	Outdoor (open)
Pumps start and stop against a closed valve.	No

Parts shall be interchangeable between units of similar size and capacity to extent practical.

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Pumping units shall be designed for the operating conditions as follows:

Pump tag numbers.	73-FSW-P-0001, 73-FSW-P-0002	
Estimated Rated head (To be coordinated with Design-builder and Cloth Disk Filter supplier).	42	ft
Capacity at rated head.	455	gpm
Operating head range for full speed continuous operation.	TBD by Cloth Disk Filter Supplier and coordinated with Design-Builder	ft
Minimum shutoff head.	TBD by Cloth Disk Filter Supplier	ft
Maximum nominal pump speed.	1800	rpm
Minimum head at reduced speed (To be coordinated with Design-Builder and Cloth Disk Filter supplier).	13	ft
Capacity at minimum head at reduced speed (To be coordinated with Design-builder and Cloth Disk Filter supplier).	225	gpm
Approximate minimum pump speed, percent of maximum.	TBD by Cloth Disk Filter Supplier	%
Maximum power required at pump input shaft at any point minimum operating head to shutoff head.	20	bhp
Minimum Efficiency.	TBD by Cloth Disk Filter Supplier	%
Type of efficiency indicated.	Wire to water	
Efficiency calculated at.	Rated head	
Pump designed for reverse rotation.	No	
Minimum NPSHA at rated head.	11.5	ft
Minimum NPSHA at minimum operating head.	20.6	ft
Maximum suction pressure.	TBD by Cloth Disk Filter Supplier (estimated at 4 psi)	psi

Pump tag numbers.	73-FSW-P-0001, 73-FSW-P-0002	
Maximum “A” rated weighted noise at 3 ft.	80	dBa
Maximum unfiltered vibration velocity.	HIS	in/s
Pump rotation as viewed from driven end.	Clockwise	
Minimum pump suction nozzle size.	TBD by Cloth Disk Filter Supplier	in
Minimum pump discharge nozzle size.	TBD by Cloth Disk Filter Supplier	in
Minimum test sphere diameter.	TBD by Cloth Disk Filter Supplier	in

All specified conditions shall be at rated speed unless otherwise indicated.

Overall (wire-to-water) efficiency for variable speed pumps shall include losses in the pump, motor, variable frequency drive, and any transformers supplied as part of the variable frequency drive equipment.

The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus maximum suction pressure.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction submergences. The design performance shall be based on a wearing ring diametral clearance of not less than 1 mil per inch of wearing ring diameter, or 12 mils total, whichever is greater.

2-3. MATERIALS. Each pump shall be constructed of the following materials as required.

Frame	Cast iron, ASTM A48.
Casing and Casing Covers	Cast iron, ASTM A48.
Casing Wearing Ring	Martensitic stainless steel, Brinell 400+.
Impeller	Cast iron, ASTM A48.
Impeller Wearing Ring	Martensitic stainless steel, Brinell 300 to 350.

Shaft	Carbon steel, AISI 1045.
Stuffing Box Hardware	Corrosion-resistant metal.
Packing	Braided, graphited or teflon impregnated Kevlar.
Lantern Ring	Bronze or glass-filled teflon for 2-1/2 inch [64 mm] OD and smaller shafts; bronze only for shafts larger than 2-1/2 inches [64 mm].
Shaft Sleeve (w/packing)	Martensitic stainless steel, Brinell 400+.
Mechanical Seal (double)	Durametallic "Double DuraSeal" or John Crane "Type 1 Multiple Shaft Seal".
Shaft Sleeve (w/mechanical seal)	Stainless steel, AISI 316
Flexible Coupling	Not required.
Bearings	Antifriction.
Baseplate	Cast iron or fabricated steel.

2-4. PUMP CONSTRUCTION.

2-4.01. Casing Assembly. The casing assembly and drive connection shall permit the removal of the rotating element without disconnecting the piping. Casing parts shall have registered fit to maintain alignment. The nozzle flanges shall be flat faced, with ANSI/ASME B16.1, Class 125 diameter and drilling.

Flanged cleanout handholes shall be provided on the pump suction and discharge nozzles. Cleanout handholes shall have interior surfaces flush with the casing water passages.

Pipe-tapped openings shall be provided for draining, priming, and venting the casing, except where Ni-hard or high-chrome cast iron casings are specified.

Cast iron casings shall be provided with plugged gauge cock connections on the suction and discharge nozzles.

2-4.02. Impeller. The impeller shall be a one-piece casting. The impeller shall be completely machined on all exterior surfaces, except when high chrome alloy material is specified. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller

shall be securely locked to the shaft so that it will not be loosened by reverse rotation, but shall be easily removable.

Type of impeller.	Open.
Impeller balancing.	Static.
Impeller to shaft attachment.	Keyed or Threaded.
Maximum number of impeller ports.	Single.

2-4.03. Shaft and Shaft Sleeves. The shaft shall be completely machined. Deflection at the stuffing box shall not exceed 0.002 inch at any head in the operating range. A suitable splash deflector shall be mounted on the shaft adjacent to the frame bearing housing.

The shaft shall be provided with a replaceable sleeve extending from the impeller through the stuffing box. The sleeve shall be positively secured to the shaft and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly on the shaft, total runout shall not exceed 0.002 inch.

2-4.04. Wearing Rings. Renewable wearing rings shall be provided in the casing and on the impeller. The rings shall be positively locked in place.

2-4.05. Stuffing Box. The stuffing box for each pumping unit shall contain a double mechanical seal. Each double mechanical seal shall be provided with a lubricating water line connection and a lubricating water bleedoff line connection. The bleedoff connection from each double mechanical seal shall be located to adequately vent the seal cavity and shall be provided with a throttling valve to control the rate of flow of lubricating water through the seal. The bleedoff line shall be piped from the stuffing box to the nearest point of drainage collection.

2-4.06. Seal Water Station. Each pumping unit shall be provided with a seal water station type C, including all piping and accessories as specified in the Seal Water Stations section.

2-4.07. Frame Assembly. The frame assembly shall rigidly support the rotating element with two bearings. The outboard bearing shall carry both axial and radial pump loads. If wearing clearance is axial, the assembly design shall permit axial adjustment of the rotor without dismantling the pump. Bearing enclosures shall keep out contaminants and retain the lubricant and shall have adequate provisions for adding and draining lubricant.

The frame shall provide ample clearance for stuffing box maintenance.

2-4.08. Bearings. Bearings shall be either oil or grease lubricated, antifriction type. Bearings shall have an ABMA L_{10} Life Rating of 40,000 hours at specified operating conditions. The pump shaft speed shall not exceed the limits specified by the bearing manufacturer.

2-4.09. Equipment Bases. Baseplates for pumps of at least 60 hp shall provide for tapered dowels to maintain alignment of pump and motor. Other requirements for equipment bases are specified in the General Equipment Stipulations.

2-5. ACCESSORIES. Each pump shall be provided with lifting eyebolts or lugs; tapped and plugged openings for casing assembly and bearing housing vents and drains; and appropriate fittings for adding bearing lubricant and seal water. Grease lubricated pumping units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2-6. DRIVE UNITS. Each pump shall be driven by an electric motor through a flexible coupling. Drive units shall be designed for 24 hour continuous service. Gearmotors shall not be used.

2-6.01. Belt Drives. Not used.

2-6.02. Couplings. Couplings shall have a horsepower rating 1.25 times the motor nameplate horsepower when the misalignment is within the manufacturer's tolerance limit. Coupling design shall permit removal of the pump rotating element without disconnecting the piping, moving the drive unit, or axial movement of the coupling halves on the shaft. The coupling shall be resilient type.

2-6.03. Electric Motors. The electric motors shall be designed as specified in the Common Motor Requirements for Process Equipment section.

2-6.04. Variable Frequency Drives. Variable frequency drives shall be provided and shall be coordinated with the requirements of the pumping unit. The pump manufacturer shall be responsible for furnishing the variable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

Variable frequency drives shall be designed as specified in the Variable Frequency Drives section.

2-7. SHOP TESTS. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, evaluated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall be made in

conformity with the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be per Table 14.6.3.4 Grade 1U, with no minus tolerance or margin allowed.

For pumping units with variable frequency drives, the wire-to-water efficiency test shall include the variable frequency drive (and transformers if supplied with the adjustable frequency drive) to be installed in the work.

For pumping units under 100 horsepower, a certified performance curve including head, pump input power, pump efficiency, and wire-to-water efficiency (when specified) shall be prepared by the pump manufacturer. A PDF copy of the certified curve shall be delivered to Design-Builder not less than 10 days prior to the shipment of the equipment from the factory.

PART 3 - EXECUTION

3-1. INSTALLATION. Each pumping unit shall be installed in accordance with the Hydraulic Institute Standards, the Equipment Installation section, and as specified herein.

The equipment base shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, connections to pumping equipment shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

Couplings shall be realigned after grouting. Final coupling misalignment shall be within one-half of the coupling manufacturer's allowable tolerance.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and

has been operated under full load conditions and that it operated satisfactorily and in accordance with the specified performance requirements.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-3.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-3.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 43 23 58

ROTARY LOBE POSITIVE DISPLACEMENT PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section covers constant speed rotary tri-lobe, positive displacement type pumping units to pump various liquid streams throughout the WRF.

Pump designation.	WAS Pump	Scum Pump	Dewatering Sludge Feed Pump*
Number of pumps.	1	1	2
Pump tag numbers.	31-WAS-P-0001	31-SCM-P-0001	72-DWT-P-0101, 72-DWT-P-0201
Pump location.	BNR	BNR	Residuals Area

*Dewatering sludge feed pumps are provided by the Dewatering System Supplier.

Each pumping unit shall be complete with pump, electric motor, gear reducer, coupling, coupling guard, pressure switches, anchor bolts, and all other appurtenances specified or otherwise required for proper operation. Each pumping unit shall be mounted on a common base. Pumps of the close coupled type, having the impeller attached directly to the motor shaft, with no pump bearings or flexible coupling, will not be acceptable. Pumps and motors shall be suitable for reverse rotation.

1-2. GENERAL. Equipment furnished under this section shall be fabricated, assembled in full conformity with drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer, unless exceptions are noted by the Design-Builder. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1-2.02. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication, assembly drawings together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section and the Schedule of Submittals Section. The data and specifications for each unit shall include but shall not be limited to, the following:

Pumps
- Name of manufacturer.
- Type and model.
- Tag number.
- Pump designation.
- RPM at maximum capacity.
- Complete performance curve showing capacity versus head and bhp.
- Maximum bhp requirements at maximum operating pressure.
- Net weight of pump only.
- Net weight of pump and baseplate.
- Size of suction nozzle.
- Size of discharge nozzle.
- Data on overtorque device.
- Type of coupling.
- Data on mechanical seals.
- Data on shop painting.

Motors
- As specified in the Common Motor Requirements for Process Equipment section.

Pressure Switches and Gauges
- Name of manufacturer.
- Type and model.
- Data sheets.

1-4. QUALITY ASSURANCE.

1-4.01. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 5 mils.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1-5. SPARE PARTS.

- A complete itemized price list of all recommended special tools, spare parts, and consumables shall be submitted.
- A set of recommended spare parts and consumables for system startup and testing shall be furnished.
- A set of recommended spare parts and consumables for one year of operation from Date of Substantial Completion or Acceptance of Final Testing, whichever is later, shall be furnished.

Where a tungsten carbide or ceramic liner is used inside the pump casing instead of wear plates, adequate spare liners shall be provided to cover the system warranty period as discussed in the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. Rotary lobe pumps will be used for varying service conditions throughout the WRF.

The pumping units shall be suitable for the following service conditions:

Pump designation.	WAS Pump	Scum Pump	Dewatering Sludge Feed Pump	
Type of environmental exposure.	Outdoor	Outdoor	Under canopy, Outdoor	
Type of Service	WAS	Scum	Sludge	
Liquid temperature range.	62 to 72	62 to 72	50 to 72	°F
Maximum solids concentration, by weight.	1	1	1	%
Typical solids concentration, by weight.	<1	<1	<1	%
Type of Solids	Sludge	Scum	Sludge	
Pumps start and stop against a closed valve.	No	No	No	

Parts shall be interchangeable between units of similar size and capacity to extent practical.

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation. Seismic design shall be in accordance with the Meteorological and Seismic Design Criteria section.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Pumping units shall be designed for the operation conditions as follows:

Pump designation.	WAS Pump	Scum Pump	Dewatering Sludge Feed Pump	
Pump tag numbers.	31-WAS-P-0001	31-SCM-P-0001	72-DWT-P-0101, 72-DWT-P-0201	
Rated total differential pressure.	9	9	18	psig
Capacity at rated differential pressure.	40	40	325	gpm
Maximum differential pressure	35	35	43	psig
Maximum pump operating speed.	300	300	300	rpm
Maximum (nominal) motor operating speed.	TBD	TBD	TBD	rpm
Pump suction nozzle size.	TBD	TBD	TBD	in
Pump discharge nozzle size.	TBD	TBD	TBD	in
Minimum pump displacement.	TBD	TBD	TBD	gallons per 100 revolutions
Maximum power required.	TBD	TBD	TBD	bhp
Max Motor nameplate rating	5	5	15	hp
Minimum NPSHA at rated head.	29.8	29.8	6.1	ft

Pump designation.	WAS Pump	Scum Pump	Dewatering Sludge Feed Pump	
Minimum test sphere diameter.	TBD	TBD	TBD	in
Minimum hydrostatic test pressure, psi	TBD	TBD	TBD	psig
High pressure discharge pressure switch setting	TBD	TBD	TBD	psig

All specified conditions are at rated speed unless otherwise noted. Pumping units shall be designed so that maximum reverse rotation will not cause damage to any component. The pumps shall not require any special procedures to re-prime if the tank liquid level on the suction side of the pump falls below the pump suction flange. Pump supplier shall coordinate this provision with the motor supplier.

2-3. ACCEPTABLE PRODUCTS. The rotary lobe pumps furnished under this section shall be as manufactured by Börger, Netzsch or equal.

2-4. MATERIALS.

Rotor Casing		
	With replaceable liner	Cast iron, ASTM A48.
	Without replaceable liner	Ductile iron, ASTM A536, Brinell 220; with internal tungsten carbide coating.
Casing Cover		Ductile iron, ASTM A536, Brinell 700+ or cast iron, ASTM A48.
Rotor		Ductile iron core, ASTM A536, with stainless steel ASTM 304 outer layer; Rotors shall have quickly-exchangeable lobe tips, with abrasion resistant Buna-N coating to suit the application.
Shaft		Carbon steel, AISI 1045.
Shaft Sleeve		11-14 percent chrome stainless steel; Brinell 400+
Gear Case Bearings		Cast iron, ASTM A48 Grade 30. Antifriction, oil lubricated.

Seal Chamber Hardware	Corrosion-resistant metal.
Mechanical Seal (single)	Single water flushed or oil-bathed.
Flexible Coupling	Resilient type; Falk "Steelflex" or Woods "Sure-Flex".
Base	Cast iron or fabricated steel.

2-5. PUMP CONSTRUCTION

2-5.01. Rotor Casing and Cover. Casings shall either be hardened steel with a ceramic liner or cast iron with replaceable liners.

The front cover shall permit unobstructed access to the rotors without disconnecting piping or disturbing glands or bearings and hardened to a minimum of 550 Brinell. Sludge pumps shall have side suction and discharge nozzles. The nozzle flanges shall be flat faced with ANSI/ASME B16.1, Class 125 diameter and drilling.

2-5.02. Rotor. The rotating element of each pump shall be of the tri-lobe or quad-lobe type. The radial location of the rotor shall be controlled by splines or keys to ensure correct rotor meshing. If splines are used, the rotor shall be securely fastened to the shaft by a locking assembly consisting of internally and externally expanding rings. Replacement of the rotor shall not require retiming the pump. The complete locking assembly shall be encapsulated within the rotor core by the front sealing flush disc and at the rear by an O-ring seal. The O-ring material shall be resistant to the fluid that is to be pumped.

The elastomeric coated rotor tips shall be guaranteed against bonding failure, otherwise known as delamination. The pump manufacturer shall verify rotor material and hardness are suitable for the application. Rotors shall be designed with individually replaceable tips.

2-5.03. Shaft and Shaft Sleeve. Shafts shall be completely machined. Each shaft shall be timed in its rotation by straight cut, zero backlash, high quality gears, keyed or locked to the shaft, and running in a separate oil chamber. Deflection at end of the shaft shall not exceed 0.006 inches.

Each shaft shall be provided with a replaceable sleeve passing through the stuffing box. The sleeve shall be positively locked against rotation and axial movement and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly on the shaft, total runout shall not exceed 0.002 inch.

The shafts shall be non-sludge wetted. The rotor/shaft connection shall be lubricated with quench fluid of the intermediate chamber. The shafts shall be timed in their rotation by straight cut timing gear running in a separate oil chamber, which also contains the ball and roller bearings for each shaft. Sludge wetted rotor/shaft connections are not acceptable.

2-5.04. Stuffing Box. The stuffing box for each pumping unit shall contain a single mechanical seal. The mechanical seal shall be provided with a lubricating waterline connection.

2-5.05. Frame Assembly. The frame assembly for each pump shall rigidly support the rotating element with two bearings. Bearings at the driven end of the frame assembly shall carry both axial and radial loads. The assembly design shall permit axial adjustment of the rotor without dismantling the pump. Bearing enclosures shall be sealed with O-rings or gaskets to keep out contaminants and retain the lubricant and shall have adequate provisions for adding and draining the lubricant.

The frame shall house the timing gears and provide ample clearance for stuffing box maintenance.

2-5.06. Bearings. Bearings shall be oil lubricated antifriction type. Bearings shall have an ABMA L_{10} Life Rating of 40,000 hours at specified operating conditions. The pump shaft speed shall not exceed the bearing manufacturer's limitations.

2-5.07. Flexible Coupling. Not used.

2-5.08. Seal Water System. Each pumping unit shall be provided with a seal water station, as required, including all piping and accessories as specified in the Seal Water Stations Section as well as indicated in the Table below.

Pump designation.	WAS Pump	Scum Pump	Dewatering Sludge Feed Pump
Pump tag numbers.	31-WAS-P-0001	31-SCM-P-0001	72-DWT-P-0101, 72-DWT-P-0201
Seal Station Water Type	Type B	Type B	Type B

2-5.09. Oil-Bathed Seal Chamber Leak Detection. Not used.

2-6. DRIVE UNITS. Each pump shall be driven by a belt drive between the motor and the pump. The nominal input power rating of the speed reducer shall

be at least equal to the nameplate power rating of the drive motor. Drive units shall be designed for 24-hour continuous service. Gearmotors shall not be used.

2-6.01. Electric Motors. The electric motors shall be designed as specified in the Common Motor Requirements for Process Equipment section.

The motor shall be suitable for reverse rotation.

Submittal information shall be submitted to show that the motor can be started and stopped as specified.

2-6.02. Belt Drive. Belt drives shall be either V-belt or cogged timing belt. V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards - Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 6 to 1. Sufficient clearance shall be provided for access to the stuffing box. Each belt drive shall include a sliding base or other suitable means of tension adjustment. Belt drives shall be the side-by-side type.

Sheaves shall be of the stationary control variable sheave ratio, sized to operate at 90 percent of the maximum sheave ratio at the specified rated speed. The sliding base for stationary control variable sheaves shall have sufficient adjustment for 80 to 100 percent of the maximum sheave ratio. Motors for stationary control variable sheave ratio shall be sized for 100 percent speed at the maximum differential head.

2-6.03. Overload Device. Each rotary lobe positive displacement pump shall be provided with an overload device mounted inside the motor control center (MCC). The Design-Builder shall be responsible for coordinating the overload device to ensure that a complete and properly operating system is furnished.

Controls for the pump equipment shall incorporate an automatic unjamming sequence. The pump shall automatically reverse rotation at least three times in a set time period in an attempt to dislodge any obstruction. The sequence shall reset to 0 should 30 seconds expire between any two jams. If the obstruction cannot be removed, the equipment shall automatically shut down and an alarm circuit shall be activated.

2-7. ACCESSORIES.

2-7.01. Pressure Switches. Pressure switches shall be provided on the suction and discharge of each pumping unit. Pressure switches shall be Ashcroft, Mercoid, Static-O-Ring Company (SOR), Barksdale. Pressure switches shall be

part of the associated pressure gauge assembly where provided, and shall be furnished with the following features:

Housing:	Minimum NEMA 4 – to be determined per NFPA 820 by pump supplier and coordinated with overall system supplier, if applicable
Switch:	Snap-action single-pole double throw; 10 ampere, 120 VAC.
Deadband:	Fixed
Setpoint:	Field adjustable with visible indication
Reset:	Manual-reset on high pressure switches

High pressure switches shall be designed to stop the pump in the event of excessive discharge pressure. Switches for scum pumps shall have a range of 50 to 200 psig, safe to 225 psig surge, set to open when pressure rises to 150 psig.

2-7.02. Gauges. Each pump shall be provided with a compound pressure/vacuum gauge in the suction piping and a pressure gauge in the discharge piping. Gauges shall be liquid-filled gauges filled to approximately 75 percent of the internal volume with glycerin or silicone oil to damped shock loads.

Gauges shall conform to ANSI/ASME B40.1 and shall be indicating dial type, direct drive type with stainless steel helical-wound capillary tube pressure sensing element. The gauge shall have a phenolic open front turret case, an adjustable pointer, a stainless steel or phenolic ring, and an acrylic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. All gauges shall be Accuracy Grade A or better.

The range of each gauge shall be in the range of 0 psi up to the highest potential pressure of the pumps with a 1.25 safety factor.

2-7.03. Isolators. Each pressure gauge and pressure switch shall be isolated from the pumped liquid by an in-line, flow-through, flange type gauge isolator where indicated on the Drawings. The isolator shall consist of a carbon steel housing, carbon steel assembly flanges, and a Buna-N flexible liner, and shall be filled with silicone oil. The isolator shall be suitable for installation between two flat-faced, ANSI/ASME B16.1, Class 125 cast iron pipe flanges and shall be tapped for a 1/2 inch NPT gauge connection. Isolators shall be Robbins & Myers "RKL Series W Pressure Sensor/Isolator", Red Valve "Series 48 Flanged Sensor", Ronningen-Petter "Iso-Ring", or equal.

2-7.04. Eyebolts. Each pump shall be provided with lifting eyebolts or lugs.

2-7.05. Fittings. Each pump shall be provided with fittings for properly adding bearing lubricant and seal water.

PART 3 - EXECUTION

3-1. INSTALLATION. Each unit shall be installed in accordance with Equipment Installation section and as specified herein.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily and in accordance with the specified performance requirements.

All costs for these services shall be included in the contract price.

3-3. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-3.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-3.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 43 25 14

SANITARY LIFT STATION

PART 1 - GENERAL

1-1. SCOPE. This section covers a package lift station to be furnished and installed complete with all equipment and appurtenances specified or required to provide a complete and satisfactory sanitary pumping installation.

Major components to be furnished shall include but not be limited to pump basin with integral valve box, basin and valve box cover, duplex submersible sewage pumping unit, guiderail pump removal system, internal piping and valves, pump level controls, and package electrical and control panel.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Design-builder. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards. The package pumping station shall be as manufactured by DXP, Flygt or equal.

1-2.01. General Equipment Requirements. Unless otherwise specified, the General Equipment Stipulations section shall apply to all equipment furnished under this section.

1-2.02. Power Supply. Power supply to equipment will be 480 volts, 60 Hz, 3 phase. If other voltages other than 480V are required by the package, transformer(s) shall be provided as part of the panel package.

1-3. SUBMITTALS. Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Basin, Valve Box, and Coverplate

Name of manufacturer.
Type and model.
Dimensions and weight.
Wall thickness.
Deflection.
Materials.

Anchoring details and calculations.
Valve materials, manufacturer, and model.

Pumps

Name of manufacturer.
Type and model.
Rotative speed.
Size of discharge.
Net weight of pump and motor only.
Complete performance curves showing capacity versus head, bhp, NPSH required, and efficiency.
Data on shop painting.

Motors

Name of manufacturer.
Type and model.
Type of bearings and lubrication.
Rated size of motor, hp.
Temperature rating.
Full load rotative speed.
Net weight.
Efficiency at full load and rated pump condition.
Full load current.
Locked rotor current.

Power/Control Panel and Components

Name of manufacturer.
Type and model.
Dimensions and net weight of complete panel.
Overcurrent characteristics and details of motor control.
Liquid level sensors with mounting details and cable lengths, and pump controls.
Power and control wiring diagram
Schematic diagram
Power and control panel dimension and layout drawings

1-7. DELIVERY, STORAGE, AND HANDLING. Delivery, storage and handling shall be in accordance with the Products, Materials, Equipment and Substitutions section.

1-8. MANUFACTURER'S FIELD SERVICES. Provide the services of the manufacturer's field services representative during installation and testing as specified in Equipment Installation Section.

1-9. SPARE PARTS. The Sanitary Lift Station supplier shall propose a list of spare parts and pricing per General Terms and Conditions.

PART 2 – PRODUCTS

2-1. SERVICE CONDITIONS. The pumping station will be located on site where indicated on the Drawings. The station will pump sanitary waste, floor washdown, process drains, and excess sample water from the entire WRF site. The waste temperature may range from 50 to 100 F.

2-1.01. Performance and Design Requirements. Each pumping unit shall be designed for the following operating conditions and requirements:

Pump tag numbers	95-SAN-P-0101 95-SAN-P-0201
Rated total head, feet	116
Capacity at rated head, gpm	300
Maximum pump operating speed at rated head, rpm	1750
Maximum bhp required at any point in the operating head range	TBD
Normal water depth in the wetwell, feet	
Minimum	1'-0"
Maximum	10'-0"
Minimum discharge size, inches	3
Minimum test sphere diameter, inches	2.25
Minimum hydrostatic test pressure, psi	1.5 x shutoff head plus suction pressure

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.01 inch or 1 mil per inch of casing wearing ring diameter, whichever is greater.

Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.

2-2. MATERIALS.

Stator Housing, Oil Chamber Housing, Impeller Casing, and Impeller	Cast iron, ASTM A48.
Shaft	Alloy steel, hard chrome plated; or martensitic stainless steel, AISI Type 416 or 420.
All Wetted Assembly Fasteners	Stainless steel.
Mechanical Seals	2 tandem single type, oil lubricated with silicon carbide seal rings at all points, except the upper rotating seal, which shall be carbon.
Discharge Base	Cast iron or fabricated steel.
Guiderails	Stainless steel pipe, ASTM A312, Schedule 40S.
Pedestal Base	Cast iron or fabricated steel.
Epoxy Coating	
Primer	Kop-Coat "Hi-Gard Epoxy", Tnemec "20-1255 Pota-Pox Primer", or Valspar "78-D-7 Tank Lining Epoxy".
Finish Coat	Kop-Coat "Hi-Gard Epoxy", Tnemec "20-2000 Pota-Pox", or Valspar "78-W-3 Tank Lining Epoxy".

2-2.01. Anchor Bolts. See General Equipment Stipulations section.

2-2.02. Painting. See General Equipment Stipulations section.

2-3. BASIN. The package pumping station shall be provided with a basin to house the pumping units and float controls, an integral valve box which shall house a check valve and plug valve for each pumping unit, a basin cover with

access hatches for pump removal and valve access, and all associated piping fittings and appurtenances required for a complete installation.

2-3.01. Construction. The basin and valve box shall be constructed of fiberglass. The basin shall be a minimum of 5 feet in diameter, and shall be a minimum of 15 feet in depth as shown in the Drawings. Lifting lugs shall be provided on the outside of the basin. Suitable means shall be provided for mounting the pumping unit, discharge base, guiderail system, piping, and controls to the basin.

The basin shall have a 48 inch deep valve box which shall be of suitable size to house the plug and check valves for each pumping unit. A 2 inch PVC gravity drain with trap shall be provided for draining the valve box to the basin. Two 4 inch sleeves and modular casing seals shall be provided for the valve box inlet and outlet piping.

The basin and valve box shall be provided with rails, flanges, or other suitable means for anchoring to a concrete base.

The basin and valve box shall be designed to withstand a soil pressure based on a soil weight of 125 pounds per cubic foot. All sizes, thicknesses, and deflection shall be acceptable to the Design-Builder.

2-3.02. Restraint. The basin and valve box shall be anchored to a concrete base to prevent movement and flotation. The anchoring system shall be designed by the sanitary lift station supplier to prevent flotation of the basin when empty and when submerged in water or shall be at least 6 feet square and 8 inches thick.

2-3.03. Coverplate. The basin and valve box shall be provided with a galvanized steel coverplate which shall be suitable for bolting to the basin and valve box. The coverplate shall be provided with access hatch, gooseneck vent, and all other required openings and support brackets for the guiderail system and float controls.

Hatches shall be provided for removal of the pumps and for access to the valving. The access hatches shall be of all galvanized steel construction, and shall be provided with two hinges per leaf, torsion bars or other devices to assist opening, an automatic hold-open arm, a retractable handle, and a padlock hasp. The coverplate and access hatches shall be designed for a live load of 150 pounds per square foot.

2-3.04. Valves. A plug valve and swing check valve shall be provided in the discharge piping of each pumping unit. The check valve shall be mounted in the horizontal position. The valves shall be nominal 4 inch size, with flanged ends.

2-4. PUMPING UNITS. The package pumping station shall be provided with two pumping units. Each pumping unit shall be guiderail-mounted, vertical, single-stage, submersible, non-clog, end suction centrifugal type.

Each pumping unit shall be complete with a close coupled, submersible electric motor; a floor-mounted discharge base and elbow; guiderails; access hatch cover; and all other appurtenances specified or otherwise required for proper operation.

2-4.01. Pump Construction.

2-4.01.01. Impeller Casing. The impeller casing shall have well-rounded water passages and smooth internal surfaces free from cracks, porosity, blow holes, or other irregularities. The discharge nozzle shall be flanged and sufficiently rigid to support the guiderail-mounted pumping unit under all operating conditions.

2-4.01.02. Impeller. The impeller shall be a semi-open or enclosed one-piece casting with not more than two non-clog passages. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced and securely locked to the shaft by means of a key and self-locking bolt or nut.

2-4.01.03. Oil Chamber Housing. The oil chamber shall contain a drain plug and a vent plug.

2-4.01.04. Mechanical Seals. Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and running in an oil chamber. The lower seal unit between the pump and the oil chamber shall contain one stationary and one positively driven rotating silicon carbide ring. The upper seal unit between the oil chamber and the stator housing shall contain one stationary silicon carbide ring and one positively driven rotating carbon ring. Each interface shall be held in contact by an independent spring system designed to withstand maximum suction submergence. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement.

Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended periods while pumping under load.

2-4.01.05. Sealing of Mating Surfaces. All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is required. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or

tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and water tightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

2-4.01.06. Discharge Base. A discharge base and discharge elbow shall be furnished by the pump manufacturer for each pumping unit. The base shall be sufficiently rigid to firmly support the guiderails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the basin. The face of the discharge elbow inlet flange shall be perpendicular to the floor and shall make contact with the face of the pump discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ANSI B16.1, Class 125.

The pump and motor assembly shall be automatically connected to and supported by the discharge base and guiderails so that the unit can be removed from the basin and replaced without the need for operating personnel to enter the basin.

2-4.01.07. Sliding Bracket. Each pumping unit shall be provided with an integral, self-aligning guiderail sliding bracket. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions.

2-4.01.08. Guiderails. Each pumping unit shall be equipped with one or more guiderails. Guiderails shall be sized to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to the top of the basin. An upper guiderail bracket of AISI Type 304 stainless steel shall be provided.

2-4.01.09. Lifting Cable. A cable suitable for removing and installing each pump shall be selected and provided by the pump manufacturer. The cable shall be stainless steel. A suitable cable hook shall be provided at the top of the basin.

2-4.02. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 5.0 mils.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

2-4.03. Electric Motors. Each pump shall be driven by an air-filled, totally submersible electric motor manufactured by the pump manufacturer. Each motor shall be rated 460 volts, 60 Hz, 3 phase and shall have a service factor of 1.05. Motor nameplate rating shall exceed the maximum horsepower required by the pump in the operating head range. The stator housing shall be an air-filled, watertight casing. Motor insulation shall be moisture resistant, Class F, 155 C. Each motor shall be NEMA Design B for continuous duty at 40 C ambient temperature, and designed for at least 10 starts per hour.

The motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The bearings shall have a calculated AFBMA L_{10} Life Rating of 40,000 hours when operating at maximum operating head. Maximum shaft runout at the mechanical seals shall not exceed 2 mils at any point in the operating head range.

Each motor shall be capable of continuous operation in air (unsubmerged) for at least 24 hours under pump full load conditions, without exceeding the temperature rise limits for the motor insulation system.

Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. Cable sizing shall conform to NEC requirements. All cables shall be of sufficient length to terminate in a junction box outside the basin at the control panel with 10 feet of slack which will be coiled in the basin. Each cable shall be supported by AISI Series 300 corrosion-resistant stainless steel Kellems or woven grips to prevent damage to the cable insulation. Mounting of cable supports in the basin shall be coordinated by the supplier to prevent damage to the cable.

The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

2-5. CONTROLS. The package pumping station shall be furnished with a factory wired control system consisting of control panel, motor starters, control transformer, local power disconnect switch, overload relays, auxiliary relays, level switches, moisture and temperature detection package, and associated appurtenances specified herein or required for a properly operating system.

2-5.01. Level Switches. Liquid level sensors consisting of an assembly of weighted ball floats with integral switches shall be furnished by the pump manufacturer. The sensors shall be suitable for duplex pump operation with high water alarm and shall be Weil "8230 Series". Each system of sensors shall be furnished complete with all required mounting brackets, weights, stainless steel mounting pipes and accessories, control power transformers, auxiliary relays, cables, and junction boxes.

2-5.02. Control Panel. The pumping units shall be controlled by a NEMA Type 4 duplex controller which will sequence and alternate pump operation in response to the float switches. The alternating of pumps should be selectable to provide Lead/Lag capability and toggling of the primary pump. Individual motor runtime indicators shall be supplied in the control panel. The control panel shall be pedestal-mounted above the package pump station. The high level switch alarm shall be wired to dry contact terminal blocks in the control panel to provide remote monitoring through the plant control system (PCS). Also, 'Pump Running' status and 'Pumping System Failure' alarm contacts shall be wired to dry contact terminal blocks in the control panel to provide remote monitoring. 'Pump Running' is active when either pump or both pumps are running. 'Pumping System Failure' relates to any alarm condition or warning condition needing attention.

The duplex controller shall be provided with:

NEMA Type 4 metallic enclosure.

One main thermal magnetic circuit breaker disconnect with external lockable operating handle.

Two NEMA rated combination magnetic motor starters with motor circuit protector and manually reset bimetallic ambient compensated overload relays.

One pump alternator.

Two control power transformers with both primary leads fused and one secondary lead fused. One secondary lead shall be grounded.

Independent control power circuit for each pump. Control power circuits shall be interlocked such that one control power circuit serves as a backup to the other control power circuit.

Ground terminal, control relays, numbered and wired terminal strip.

Two 3 position "Test-Off-Automatic" selector switch for pump operation. Selector switch shall be spring return from Test to Off position. In "Test" position the pump shall run, in "Off" position the pump shall be off, in "Automatic" position the pumps shall run as specified in the control sequence paragraph.

One high water alarm “Test-Auto-Silence”. Switch shall be spring return from Test and Silence position to Auto position.

One high water audible alarm horn and silence pushbutton and alarm light. Alarm horn shall be 4-inch, 95 dB at 10 feet and shall be mounted on the bottom of the cabinet. Alarm light shall be a red flashing light mounted on top of the cabinet.

Two green running lights, two white control power on lights, two amber motor overload lights.

Two elapsed time meters.

Two sets of isolated dry type contacts for high water alarm, one set of isolated dry type contact for common failure (motor overload, temperature, etc.) and one set of isolated dry type contacts for either pump running status.

One alarm reset pushbutton. This button shall reset all alarm contacts. Alarm lights shall stay illuminated until the alarm condition is cleared.

2-5.03. Sequence of Operation. Upon a rise in liquid level, a float switch will start the lead pump. If the level continues to rise, a float switch shall energize the lag pump. Upon a further rise in liquid level, a float switch shall energize the high water audible and visual alarms and activate the remote alarm. When the liquid level falls to the low float level, the pumps shall be de-energized. The control system shall automatically alternate the lead and lag pumps. Initial float setpoints are as follows:

	Distance Above Basin Floor
Lead pump start, ft	4.0
Lag pump start, ft	6.0
High water alarm, ft	7.0
Pumps off, ft	Per manufacturer’s recommendation

2-5.04. Pump Controls. Each motor shall be protected by motor temperature switches mounted in each phase winding and designed to operate at 140 C"5 C. Thrust bearings shall be protected by temperature switches. The air-filled chamber shall be provided with a moisture detection system. The system shall be furnished by the pump manufacturer, complete with all sensors, cables, control power transformers, intrinsically safe control modules, auxiliary relays, junction boxes, and control enclosures. The monitoring devices shall be suitable for operation with a 24 volt ac supply from the CPT and provide output contacts rated at least 5 amperes at 120 volts ac, and shall be provided with manual reset.

PART 3 – EXECUTION

3-1. INSTALLATION. Each pumping unit will be installed in accordance with Equipment Installation Section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. After installation, the manufacturer's field services representative shall inspect and approve the installations as specified in Section 01620.

3-2.02. Pre-Startup Test and Checks. Perform pre-startup tests and checks in accordance with the requirements specified in the Startup and Testing section. Testing shall not begin until installation checks by the equipment manufacturer have been completed.

3-2.03. Startup and Testing. Startup and testing requirements shall be as specified in the Startup and Testing section. Startup tests will be performed by the Design-Builder, under the supervision of the Startup Manager with the Owner's participation as specified, to determine that all features and equipment systems and subsystems have been properly designed, manufactured, installed and adjusted, function properly as specified and are capable of operating simultaneously and continuously in the local and remote-control modes at all capacities throughout their operating range.

3-3. TRAINING. Provide training per the Demonstration and Training section.

End of Section

Section 43 25 15

WATER PRESSURE BOOSTER SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of packaged water pressure booster systems and controls for the Plant Recycled Water (PRW) Pump Station as shown on the Drawings. The packaged system shall be provided by a single PRW Pump Station (PS) Supplier on a single skid.

Pumps	
Pump designation.	PRW Pump
Number of pumps.	3 (2 duty/1 standby)
Pump tag numbers.	34-PRW-P-0101
	34-PRW -P-0201
	34-PRW -P-0301
Tank	
Number of tanks.	1
Tank tag number.	34-PRW-T-0001
System location	Area 34

The system shall be furnished complete with vertical multi-stage pumps, motors, valves, piping, fittings, wiring, controls, VFD's, support bases, and all other appurtenances specified or required for proper operation of the equipment.

The system shall be furnished as a complete factory assembled package as much as possible, requiring only discharge header connections, power supply connection, wiring between skid, VFD, and LCS and remote monitoring and alarm wiring connections.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Requirements, the requirements specified herein shall take precedence.

1-2.02. Power Supply. The power supply to the equipment shall be 480V, 3 phase, 60 Hz. The system control panel shall include control power transformers to provide lower control voltages as needed by the system.

1-2.03. Mechanical Identification. Equipment and valve identification shall be in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumping Package
- Name of manufacturer.
- Type and model.
- Dimensions of skid structural members.
- Dimensions and locations of suction and discharge piping headers.
- Weight.
- Pipe supports.
- Data on shop painting.

Pumps
- Name of manufacturer.
- Type and model.
- Design rotative speed.
- Type of pump bearings.
- Weight.
- Complete performance curves showing capacity, head, NPSH requirements, efficiency, and bhp requirements.
- Data on shop painting.

Motor
- Name of manufacturer.
- Type and model.
- Rated size of motor, hp and service factor.
- Type of bearings and lubrication.
- Temperature rise and insulation class.
- Full load rotative speed.
- Weight.
- Efficiency at full, 3/4, and 1/2 load.
- Rated full load current.
- Locked rotor current.
- Space heater wattage.

Control System
- Control panel enclosure layout and dimensions.

Electrical schematics and wiring diagrams.
Data on flowmeter, pressure switches, motor starters, control power transformers, and selector switches.
A recommended sequence of operation, including values and ranges for time delays, speeds, and other set points for use in the initial startup of the system.

Variable Frequency Drives (VFD)

Name of manufacturer.
Type and model number.
Rated drive input kVA and output kVA.
Percent efficiency at 100 percent speed and 60 percent speed.
Schematics, including all interlocks.
Wiring diagrams, including all internal and external devices and terminal blocks.
List of diagnostic indicators.
List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.

1-3.02. Operations and Maintenance Data and Manuals. The PS shall furnish complete O&M manuals to install, operate, maintain, and lubricate each component of mechanical and electrical equipment. The manuals shall comply with the requirements described in the Submittal Procedures section.

1-4. SPECIAL TOOLS AND SPARE PARTS. The PRW PS shall provide spare parts per the general Terms and Conditions. The following shall be provided as a minimum:

- Any special tools required for installation or maintenance of any of the furnished equipment shall be furnished.
- A complete itemized price list of all recommended special tools, spare parts, and consumables shall be submitted.
- A set of recommended spare parts and consumables for system startup and testing shall be furnished.
- A set of recommended spare parts and consumables for one year of operation from Date of Substantial Completion or Acceptance of Final Testing, whichever is later, shall be furnished.

1-5. DELIVERY, STORAGE, AND HANDLING. The PRW PS shall coordinate with the Design-Builder and shall deliver the membranes for tank installation in accordance with the general Terms and Conditions of this procurement package.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The pressure booster system will boost the pressure of the plant recycled water system. Water temperature may range from

35°F to 80°F. Plant recycled water may contain particulate matter and other solids.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Performance and design requirements shall be as specified below. Pump requirements shall be at rated flow.

System discharge pressure, as measured at pumping package discharge header downstream of pump PRV's	60-80	psig
Rated flow	75	gpm
Head at rated flow	189	ft
Number of pumps	3	
Pump type	multistage	
Minimum pump efficiency at rated pressure	68	%
Maximum rotative speed	3600	rpm
Motor Horsepower	7.5	hp

2-3. ACCEPTABLE MANUFACTURERS. The pumping units provided as a part of the booster system package shall be as manufactured by Aurora, Berkeley, Crane-Demming, Grundfos, Goulds, Fairbanks Morse, Floway, Flowserve or equal.

The package pressure booster system shall be supplied by SyncroFlo, Inc, Metropolitan Industries Inc., Flowtronex PSI Inc., Aurora or equal.

2-4. MATERIALS. Materials in contact with the pumped fluid shall meet all applicable requirements for recycled water systems for irrigation. The system materials shall be compatible with water receiving a 1 mg/L sodium hypochlorite dose.

Pumping Package

Suction and Discharge Piping	Schedule 40 PVC
Discharge Pipe Fittings	Steel, flat faced flanges.
Miscellaneous piping, 2 inches and smaller	304 SS
Isolation Valves, 3 inch and larger	Butterfly, ANSI/AWWA C504, Class 150B, cast iron body, flanged ends cast iron disc with Nl-chrome edge, stainless steel shaft.

Isolation Valves, 2-1/2 inch and smaller	Ball, full port, bronze.
Regulating Valves	Silent wafer check valve with 316 SS disc
Equipment Base	Structural steel.

Pumps

Suction/discharge casing assembly.	AISI Type 316.
Motor stool.	Cast iron, ASTM A48.
Impeller and impeller casing.	AISI Type 316.
Pump shaft.	AISI Type 316.
Mechanical seal type.	Single mechanical type, with tungsten carbide seal faces mounted in stainless steel components.
Coupling.	Cast iron.
Bearings.	As determined by PRW PS Supplier.

2-5. CONSTRUCTION.

2-5.01. Physical Dimensions, Size and Orientation. The physical dimensions of the pumping package shall not exceed that which would allow installation where indicated on the drawings without disassembly of the unit.

The suction and discharge header design requirements are as follows:

Suction header size	2	in
Discharge header size	2	in
Suction/discharge header orientation	Opposite end	

2-5.02. Accessories. System connections to the discharge headers shall be flanged for pipe sizes 2 inch and larger and threaded for pipe sizes 2 inch and smaller. Each header shall be provided with a drain valve with 3/4 inch hose connection at the low point of the respective header.

Pressure gauges and pressure switches shall be provided to monitor the suction and discharge pressure of each pump. Suction and discharge pressure gauges shall be 4-1/2 inch ASA Grade A type and located at point of pressure sensing. Pressure switches shall meet the Pressure and Level Instruments section requirements.

An inline magnetic flowmeter shall be provided to monitor system flow and to control pump operation. The discharge header shall include additional “meter

run" length for proper installation of the flow tube. The flowmeter shall be rated for a maximum of 150 psig and it shall be accurate to plus or minus 1 percent of full scale. System flow in gallons per minute shall be displayed at the system control panel. Flanged in-line flowmeters shall be provided with upstream and downstream isolation valves and a valved bypass to allow removal of the flowmeter without shutting down the pumping system.

Each pump shall be provided with discharge check valve, isolation valve, pressure gauges, pressure switches, isolation valves, and an air release valve. The pump discharge header shall have a pressure transmitter and pH instruments as shown in the Drawings.

Flexible connectors shall be furnished and installed for the discharge header connections where indicated on the Drawings. The connectors shall be multiple arch type with TFE T62 teflon bellows, monel reinforcing rings, control units, and flanged ends. The connectors shall be designed for use with water at a pressure of 150 psig and a temperature of 100°F. Flexible connectors shall be Resistoflex Corporation "Model 6904" or equal.

All piping and accessories shall be structurally supported from the common steel base to prevent transfer of stresses to the pump flanges or the connecting piping.

A hydropneumatic tank shall be provided to allow pumps to shutdown during low flow conditions and to prevent frequent starts/stops of the pumps. The tank shall be of welded steel construction and shall be ASME code stamped for at least 150 psig working pressure. The tank shall have a minimum volume of 900 gallons and shall be vertically mounted on the skid system. The tank shall be equipped with bladder access flange, drain, air charging valve, pressure gauge, pressure relief, lifting lug, system connection, and heavy-duty replaceable bladder of butyl rubber, and shall be suitable for use with recycled water. The air chamber will be pressurized to a maximum pressure of 80 psig by the Design-Builder. The tank shall be provided with a corrosion resistant factory finish.

2-6. ELECTRIC MOTORS. Motors furnished with equipment shall meet the following requirements:

a. Shall be totally enclosed type with a continuous moisture drain that excludes insects.

b. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

c. Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

d. To ensure long life, motors shall have nameplate horsepower [kW] equal or greater than the maximum load imposed by the driven equipment and shall carry a minimum 1.15 service factor on line power and 1.0 service factor on inverter power.

e. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

f. Motors shall include a space heater to prevent condensation on the core and windings. Space heaters shall be suitable for 120 volt, 60 Hz, single phase power. Space heater leads shall be brought out through the motor terminal box for wiring in conduit. Motor space heaters shall be wired through a VFD normally closed contact and served from the VFD's 120 volt control power transformer.

g. All motors shall be premium efficiency type.

h. Each motor shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amperes at 120 volts ac. The contacts shall be wired in series, with the end leads brought out to the motor terminal box. Switches shall be as recommended by the motor manufacturer.

i. Motors shall be specifically selected for service with a variable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when operating in the installed condition at load with power received from the variable frequency drive. All motors used with drives shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG1, Part 31.

2-7. PRESSURE SYSTEM OPERATION. The pressure system shall boost the water supply pressure, with one or more pumps running intermittently or continuously. Pumps shall be energized and de-energized automatically based on system demands.

2-8. CONTROL SYSTEM. The packaged pumping system shall be provided with a microprocessor-based control system and an VFD for each motor to provide automatic and manual control of each pump. The control system shall be provided with all necessary panels, flowmeters, pressure sensors, level sensors, switches, indicating lights, alarms, starters, a 120 volt control power transformer, and other controls as needed for a complete and satisfactorily operating system as described herein. The control system shall incorporate provisions for proper automatic pumping system operation in the event of VFD failure. Pumping system operation shall be based on a combination of flow rate,

speed, pressure, and timing. System flow rate in gallons per minute shall be displayed at the control panel.

The control system shall include a trend feature which records and displays system flow, pH and pressure for a minimum 48 hour interval.

2-8.01. Sequence of Operation. A suggested sequence is given below. The PRW PS is responsible for providing a fully functional control system to maintain the discharge pressure close to the specified value for the entire operating flow range. Any instruments required to achieve this shall be included in the bid.

Each pump shall be controlled by an individual "ON-OFF-AUTO" selector switch located on the face of the package unit control panel. When the selector switches are in the “AUTO”, the lead pump shall operate at varying rates of speed as required to maintain system pressure and meet the system flow demand. Before the flow demand exceeds the capacity of the lead pump, the first lag pump shall be energized and shall operate at a speed to maintain system pressure and meet the flow demand. The third lag pump shall be energized if the capacity of the two operating pumps is exceeded. As the water demand decreases, the first and second lag pump shall be de-energized. The control system shall provide manual and automatic selection of lead pump. When in the automatic mode, the system controller shall automatically alternate lead, first lag and second lag pump status. Once energized, each pump shall remain operating for a minimum of 15 minutes (adjustable).

The pumping system shall restart automatically with an adjustable time delay after a power failure. If the pumping system receives a “Backup Emergency Power” signal from the plant control system, then only the lead pump shall be allowed to run until the “Backup Emergency Power” signal contact has been cleared. In addition, the control system shall incorporate an adjustable time delay feature that will prevent multiple pumps from being started simultaneously.

2-8.02. Pressure relief valve. At the common discharge header, a pressure relief valve shall be provided as shown on the Drawings to relieve high pressures.

2-8.03. Control Panel. The control panel and all other electrical enclosures shall be rated NEMA Type 4 for outdoor installation. All wiring to external devices shall terminate on numbered, pressure type terminal blocks. The Control Panel and VFDs shall be installed with the packaged system. The control panel shall be furnished with VFDs as specified in the VFDs section.

Control power transformers shall have one secondary lead fused, the other grounded, and shall have capacity for all simultaneous loads. The complete control panel shall be rated for a short circuit current of 22,000 amperes at 480 volts ac.

All selector switches and indicating lights shall be 30.5-mm heavy-duty, oil-tight type. Indicating lights shall be of push-to-test type, full voltage lamps.

All relays shall have contacts rated 10 amperes at 120 volts ac.

The Plant Control System (PCS) shall provide remote monitoring of the local controls, statuses and process values in this package. All contacts required for remote annunciation at the Plant Control System shall be provided in the package water system control panel. Normally-open dry contacts and 4-20 mA signals shall be provided for the conditions indicated below. Additional contacts shall be provided as recommended by the manufacturer for proper operation of the equipment.

Low suction pressure

High discharge pressure

Individual pump running

Individual pump fail

Individual pump in-remote

Individual pump speed

System Flow (GPM)

System Pressure (psi)

System pH

pH Analyzer Fail

Additionally, the system controls shall accept a remote “Emergency Backup Power” discrete signal from the plant control system. When this contact has been asserted or enabled, the pump control system shall only allow the lead pump to operate.

2-8.04. Outdoor Equipment. Electrical equipment, instrumentation, and devices located outdoors shall be designed so that they operate properly for the ambient temperature range 18-110° F. When equipment is located in a control panel or enclosure outdoors, the Supplier shall de-rate components as required so that the components will operate properly when the external ambient of the control cabinet or enclosure is 110° F and the solar radiation is 100 watts per square foot. A sunshade is provided for the control panel/VFD area, as shown on the Drawings. If additional sunshades are required to protect any other item, the Supplier shall coordinate and provide them at no extra cost to the Contract. All the equipment supplied shall be suitable for operation in the outdoor environment without any air conditioning or ventilation.

2-8.05. Variable Frequency Drives. Each variable frequency drive shall be an

AC powered, IGBT power transistor based, variable-torque, pulse width modulation type inverter. The inverter shall use a medium carrier frequency for low drive noise and motor sing. A digital readout shall be included that displays all adjustment settings, fault conditions, diagnostic codes, status, and speed. The inverter shall be able to be run normally without a load connected so that it may be tested. A set of high speed, current limiting fuses and MOV's shall be provided to protect the inverter from faults. Each variable frequency cable shall have a separate circuit breaker mounted on the face of the enclosure.

The variable frequency drives shall be provided with the necessary equipment to protect the drives, and the power system ahead of the drives, from harmonic distortion. Harmonic distortion abatement equipment shall be provided to bring the system into compliance with IEEE 592. Individual harmonic filters shall utilize an interlocking contactor that is automatically operated by its associated drive's run circuit.

2-8.06. Programmable Controller. Provide a programmable controller to control all functions of the system. Timers, clocks, motorized switches, and other devices are not acceptable. Relays may only be used to interface or provide "dry contact" points for remote signal input or readout.

The programmable controller shall be factory installed and have provisions for field reprogramming using a laptop computer. The controller program shall provide the following operational features:

a. Successive and 24-hour alternation of equal capacity pumps.
b. Pump overlap during 24-hour alternation.
c. An auto-pressurizing mode with adjustable settings that gradually restores system pressure to protect the piping at station startup and after extended station shut downs.
d. A pressure start time delay, a stop time delay, on and off flow sequencing set points, and a minimum run timer with automatic and manual time out shall be provided for each pump. A 100 percent speed start time delay shall be provided for each pump.
e. Special sequencing to reduce surges during power restoration.
f. Sequential sequencing pumps with appropriate time delays.
g. Minimum run and stop delay timer for each pump.
h. Alarm time delays and alarm horn pulsating function.
i. Trend feature which records and displays system flow, pH and pressure for a minimum 48-hour interval.

An Operator Interface Terminal (OIT) shall be provided flush mounted on the control panel face. To ensure reliable communications, the programmable

controllers internal power supply shall be used to power the operator interface terminal only. The interface shall include a keypad with audible key press feedback and a 2 line x 80 character, high visibility, LED backlit, LCD display. The interface shall also include 12 function keys with custom labels that clearly define frequently used functions such as system status, alarms, totals, etc. Function keys with generic labels such as F1, F2, etc., shall not be accepted. If the interface fails, a signal shall be sent to the PLC, and the station will continue to run normally. The operator interface shall provide access to all appropriate system data, such as the flow rate, system pressure, set point, set point mode, inverter speed, total gallons pumped, gallons per day, total pump starts and run hours, manual speed control, operational settings, and alarm status, last alarm, alarm history, and alarm light test. The interface shall also provide protected access to changing all operational set points, flow rates, pressure, speed, and time delay settings.

An alarm history function shall be provided that records a snapshot record of the system conditions at the time of any alarm or alarm reset. 200 records shall be kept in chronological order and each record shall include the following data: alarm code, date, time, flow rate, system pressure, set point, pumps running, and mode code. The alarm history key on the operator interface shall provide easy access to the alarm history records. An additional operator interface key shall provide one touch access to the last alarm record.

In addition to the keeping the totals for gallons pumped, pump starts and pump run hours, the operator interface shall also display the total gallons pumped for each of the last 30 days.

Mode status, digital manual speed control, an alarm light test function, and individual alarm status screens shall also be provided with separate operator interface function keys.

2-8.07. Miscellaneous Controls. Provide a 3-phase power monitor to measure the main incoming power to the motor panel. The monitor shall be a UL recognized component capable of detecting loss of phase, phase reversal, and low voltage on any phase. It shall feature an adjustable voltage range, an adjustable trip delay, and automatic reset.

Provide a 115 VAC to 24 VDC power supply to power to the programmable controller inputs and other 24 VDC powered devices. The use of the programmable controller on-board power supply for this purpose is not acceptable. The power supply shall have a .3-amp output rating, a voltage adjustment, a run light, a built-in noise filter, and built in over current protection with automatic reset.

2-8.08. Alarm Systems. Local indication of alarm conditions shall be provided on the face of the control panel via a general alarm light or multiple alarm lights

and an alarm horn. Specific alarm messages shall be provided on the operator interface screen where a general alarm light is used.

An alarm package shall be provided which includes a low system pressure alarm with trip time delay and manual reset; a high system pressure alarm with trip time delay and manual reset; pump failure alarms with trip time delay and manual reset; a high flow rate alarm with trip time delay and manual reset; an irregular power alarm with trip time delay, with manual and delayed automatic reset; individual motor overload alarms with manual reset; individual motor contactor fault alarms with manual reset; pressure transmitter failure alarm with manual reset; high panel temperature alarm with trip time delay and manual reset; and a VFD fault alarm with a two attempt automatic reset. Pumps shall be shutdown with the appropriate alarm whether they are operating in ON or AUTO mode.

2-9. SHOP TESTS. The pumps shall be tested at the factory as a complete unit for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. If possible, the PRW PS package shall be operated from minimum through maximum system capacity to assure proper control sequence and control stability throughout the pumping range. The hydraulic test pressure shall be at least 150 psig. All tests and test reports shall conform to the requirements and recommendations of the Hydraulic Institute Standards. If the PRW PS System could not be tested as a complete package at the factory, the pumps and control panels shall be tested separately, and a combined field testing shall be done by the PRW PS Supplier to establish satisfactory operation of the system.

If the PRW PS System fails to operate properly or fails to meet the specified conditions or requirements during testing, the PRW PS Supplier shall modify the package and perform additional tests.

A PDF certified copy of a report covering each test shall be prepared by the package system manufacturer and delivered to Design-Builder not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, power, pump efficiency, rpm, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements, with all test points clearly shown. When the pump is not tested at the rated speed, performance charts shall include both the test speed and the calculated speed curves.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation will be in accordance with the Equipment Installation section.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. After installation, the manufacturer's field services representative shall inspect and approve the installations as specified in the Equipment Installation Section.

3-2.02. Pre-Startup Test and Checks. Perform pre-startup tests and checks in accordance with the requirements specified in the Startup Section. Testing shall not begin until installation checks by the equipment manufacturer have been completed.

3-2.03. Startup and Testing. Startup and testing requirements shall be as specified in the Startup Section. Startup tests will be performed by the Design-Builder, under the supervision of the City's participation, to determine that all features and equipment systems and subsystems have been properly designed, manufactured, installed and adjusted, function properly as specified and are capable of operating simultaneously and continuously in the local and remote control modes at all capacities throughout their operating range.

3-3. TRAINING. Provide training as specified in the Demonstration and Training Section.

End of Section

Section 43 25 60

SUBMERSIBLE HORIZONTAL PROPELLER PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section specifies the horizontal submersible propeller pumps for installation as indicated on the Drawings.

Pump designation.	MBR Feed Pumps
Number of pumps.	2
Pump tag numbers.	31-BNR-P-1001, 31-BNR-P-2001
Pump location.	Mixed Liquor Collection Channels

Each installed pumping unit shall be complete with a submersible electric motor, adjustable frequency drive, mounting assembly for installation as indicated on the Drawings, and all other appurtenances specified or otherwise required for proper operation, including special tools.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Design-Builder. Definition of terms and other hydraulic considerations shall be as set forth in the Hydraulic Institute Standards.

Each unit shall be furnished and installed complete with all anchors and supports, all mechanical equipment required for proper operation, and all additional materials or construction required by the manufacturer's design.

The propeller pumps specified herein shall be designed and fabricated by a single manufacturer which shall have sole responsibility for the equipment. The manufacturer shall have pumping equipment of this design and of comparable capacity in successful operation for at least 5 years.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.04. Identification. Submersible horizontal propeller pumps shall be identified in accordance with the Equipment and Valve Identification section.

1-2.05. Spare Parts. A list of recommended spare parts shall be provided by the manufacturer in accordance with the general Terms and Conditions.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials used, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but are not limited to, the following:

Propeller Pumps
- Name of manufacturer.
- Type and model.
- Tag Number.
- Pump Designation.
- Pump Location.
- Rotative speed.
- Type of bearings.
- Net weight of propeller pump and motor.
- Complete performance curves showing capacity versus head, minimum submergence required, pump efficiency, wire-to-water efficiency, and pump input power.
- Data on shop painting.
- Anchor bolt details.

Motors
- Name of manufacturer.
- Type and model.
- Type of bearings and lubrication.
- Rated size of motor, hp.
- Temperature rating.
- Full load rotative speed.
- Efficiency and power factor at full load and rated pump condition.
- Full load current.
- Locked rotor current.
- Data on cable.

Variable Frequency Drives
- As specified in the Variable Frequency Drives section.

Moisture Detection System
Name of manufacturer.
Type and model.
Published descriptive data on each item of equipment and all accessories, indicating all specific characteristics and options.
Seismic Design Requirements
Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instruction or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The propeller pumping units will feed mixed liquor from the BNR tanks to the MBR tanks. The PCS will control the pumps to match the BNR influent flow and the RAS flow.

The equipment provided under this section shall be suitable for the following service conditions:

Maximum liquid temperature.	62 to 72	F
Maximum solids concentration, by weight.	<1	%
Seismic design requirements	As specified in the Meteorological and Seismic Design Criteria section	

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at the elevation specified in the Meteorological and Seismic Design Criteria section.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The propeller pump with its appurtenances and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 100 feet. The propeller pumping units shall be provided with a mounting system including a hoist, which enables the unit to be raised, lowered, and easily removed from the basin without the need for personnel to enter the basin.

The propeller water horsepower requirements, gear losses, and an ample allowance for buildup of biological solids on the propeller of the unit shall be included in determination of the brake horsepower requirements.

Pumping units shall be designed for the following operating conditions, unless otherwise noted:

Pump tag numbers.	31-BNR-P-1001, 31-BNR-P-2001	
Rated head.	2.8	ft
Capacity at rated head per pump	4030	gpm
Operating head range for full speed continuous operation.	1.5 to 4.0	ft
Maximum nominal pump speed.	1200	rpm
Minimum head at reduced speed.	3	ft
Capacity at minimum head at reduced speed.	695	gpm
Approximate minimum pump speed.	600	rpm
Maximum motor nameplate power	15	hp
Efficiency at rated head, wire to water.	40	%
Minimum submergence	2	ft
Basin depth (guide-rail mounted).	11	ft
Minimum liquid depth in basin (guide-rail and skid mounted)	6.4	ft
Maximum propeller diameter.	24	in

Overall (wire-to-water) efficiency for variable speed pumps shall include losses in the pump, motor, adjustable frequency drive, and any transformers supplied as part of the adjustable frequency drive equipment.

2-3. ACCEPTABLE MANUFACTURERS. The submersible propeller pumping equipment shall be as manufactured by Flygt Corporation, Landia, and KSB, without exception.

2-4. MATERIALS. Pumps and accessories shall be constructed of the following materials.

Guide Bar System

Guide Bars	Stainless steel pipe, Schedule 40S, AISI Type 316
Upper guide bar holders and intermediate guide bar supports	Stainless steel, AISI Type 316
Lifting Cable	Stainless steel, AISI Type 316.
Retaining Chain	Stainless steel, AISI Type 316.
Lifting Bracket or Bridle Chain	Stainless steel, AISI Type 316.
Propeller Pump	
Stator housing and oil chamber housing	Stainless steel, AISI Type 316.
Propeller Shaft	Alloy steel, hard chrome plated; or stainless steel, AISI Type 316.
Propeller Shaft Mechanical Seal	Stainless steel with tungsten carbide or silicon carbide rings.
Motor Shaft Mechanical Seal	Stainless steel with tungsten carbide or silicon carbide rings.
Propeller	Same as stator housing.
Inlet Cone	Stainless steel, AISI Type 316.
All Assembly Fasteners	Stainless steel, AISI Type 316.
Primer and Finish Coat (Note)	
Epoxy	PPG Amercoat "Amercoat 385 Epoxy", Carboline "Carboguard 890", ICI Devoe Devran "224HS", Tnemec "Series N69 Hi-Build Epoxoline II", or Sherwin-Williams "Macropoxy 646".

Note: The manufacturer's coating recommended for the specified service that is equivalent to the specified coating will be acceptable.

Where stainless steel components are welded, the stainless steel shall be AISI Type 316L.

All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test for a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces contaminated or damaged during fabrication including welded areas shall be repickled or passivated in accordance

with ASTM A380 as needed to remove all traces of iron contamination and heat

tint. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2-5. CONSTRUCTION.

2-5.01. Propeller Pump. Each propeller pump shall be the direct-driven, close-coupled, submersible type. All components of the unit, including motor and gear box, shall be designed for the specified requirements of pump service and shall be capable of continuous underwater operation. In addition, all components of the unit, including motor and gear box, shall be capable of continuous operation in air, completely unsubmerged, for 2 hours.

A sliding bar guide bracket shall be an integral part of the pumping unit. The entire weight of the mixer unit shall be guided by a single bracket which shall be capable of handling all thrust created by the mixer.

Cast components shall have smooth surfaces devoid of blow holes and other irregularities.

Each pumping unit shall be equipped with an integral inlet cone and use a wall mounting plate or pipe adapter as indicated on the Drawings. The design of the inlet cone shall ensure good hydraulic efficiency.

If required per manufacturer, a vortex baffle plate shall be provided on the pump to improve performance due to low water submergence levels indicated in the performance criteria.

2-5.02. Propeller. The propeller shall consist of two or three blades, each integrated on a shaft for mounting in a hub. The blades shall be dynamically balanced and of non-clogging backward curve design.

2-5.03. Oil Chamber Housing. The oil chamber shall contain an inspection plug, drain plug, and vent plug.

2-5.04. Mechanical Seals. Each pump shall be provided with a lapped end face type mechanical seal (propeller shaft) and two lip seals (gear box for gear-driven mixers), running in oil reservoirs for cooling and lubrication. The mechanical seal between the propeller and propeller shaft oil chamber shall contain one stationary and one positively driven rotating face ring running in an oil reservoir for cooling and lubrication. The seals between the shaft and gear box, and gear box and motor chamber shall be of the lip style. All seal springs shall be isolated from the pumped liquid.

Four seals separating the various parts as specified herein will also acceptable.

The outer seal in the propeller hub shall be either a viton or nitrile rubber lip seal, sealing propeller shaft and grease chamber from the mixed media running on a replaceable stainless steel bushing. The two inner seals on the propeller shaft shall be either viton or nitrile rubber lip seals insulating the propeller shaft grease chamber from the gearbox oil chamber. The fourth seal shall be a mechanical seal running in the oil for cooling and lubrication. It shall be mounted on the motor shaft to insulate the gear box oil chamber from the dry motor stator housing.

The seals shall require neither maintenance nor adjustment, but shall be easy to check, relap, and replace. Neither shaft seals lacking positively driven rotating members nor conventional double mechanical seals which use a common single or double spring and require a pressure differential to offset external pressure and effect sealing will be acceptable.

2-5.05. Sealing of Mating Surfaces. All mating surfaces shall be machined and fitted with nitrile rubber O-rings where watertight sealing is required. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain gasket or seal compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

2-5.06. Pump Mounting Assembly. Each pumping unit shall be furnished with a vertical guide rail system and wall mounting plate. Two 2-inch, 316 stainless steel, Schedule 40S pipes shall be provided to guide the pump during installation and removal. Guide rail holders of 316 stainless steel shall be furnished and installed. Upper guide bar holders shall be furnished and installed to connect the top of the guide bar system to the structure as depicted on the Drawings. Lower guide rail holders shall be furnished and installed to connect the bottom of the guide bar system to the bottom slab or to the flange of the discharge pipe.

The mounting plate for pumping units shall function as a quick disconnect discharge connection for the pumping unit. The plate shall be suitable for mounting to a pipe, as indicated on the Drawings. The pumping unit shall interlock with the mounting plate to form a metal-to-metal seal between the pump and the discharge connection. No gaskets, O-rings, or other sealing arrangements shall be required to seal the discharge connection. The pumping unit shall not require any bolts, nuts, or fasteners to mount to the discharge connection.

2-5.07. Hoist Assembly. One removable manual winch assembly shall be provided to use for both pumps. The winch assembly shall be shared by two pumps. The winch assembly shall consist of a lifting davit, winch, and 40 feet of

0.25-inch 316 stainless steel lifting cable. The lifting davit assembly shall be

constructed of 316 stainless steel and shall be mounted in flush mounted mast wells. The boom arm shall be adjustable and the length shall be suitable for the pump installation. The boom shall provide a rotation of 270 degrees. The winch assemblies shall provide a minimum working capacity 50 percent greater than the pumping unit weight. The winch assembly shall be capable of picking up the pump perpendicular to the pump direction as indicated on the drawings.

Each pumping unit shall utilize a positive means of submersible propeller pump recovery, similar to the Flygt "Grip Eye" system. A stainless steel guide cable shall be attached to the pump lifting chain and to a stainless steel eyebolt attached to the basin wall via a quick disconnect clip. The lifting cable assembly shall normally remain attached to the pump so “fishing” is not required to establish a positive connection. The grip eye shall be connected to the end of the winch lifting cable. The supplier shall furnish all necessary appurtenant items required to facilitate these connections.

The hoists shall be capable of being moved to any pump location and shall not weigh more than 225 pounds. Suitable lifting handles shall be provided. The pump guide bar assemblies shall be compatible with the hoist and provide a cable quick disconnect feature, similar to the Flygt "Grip-Eye" system so the pump lifting cable can be left permanently attached to the pumping units.

2-5.08. Bolts and Nuts. Field assembly bolts and nuts and anchor bolts and nuts shall be provided for each item of equipment. Anti-seize compound shall be applied to the threads of all stainless steel bolts before assembly.

2-6. BALANCE AND VIBRATION. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. At any operating speed, the ratio of rotation speed to the critical speed of the unit or components thereof shall be less than 0.8 or more than 1.3.

2-7. FABRICATION AND MANUFACTURE.

2-7.01. Welding. All welded joints shall be sealed watertight with continuous welds.

2-7.02. Edge Grinding. Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius as necessary to ensure satisfactory paint adherence.

2-7.03. Surface Preparation. All welds shall be thoroughly cleaned and ground

smooth in preparation for painting. All ferrous metal surfaces, except motors, speed reducers, and stainless steel, shall be solvent cleaned in accordance with SSPC-SP1 before shop primer is applied.

2-7.04. Shop Painting. All iron and steel parts, except for stainless steel parts, which will be in contact with liquid or submerged after installation shall be shop cleaned in accordance with the coating manufacturer's recommendations and painted with an epoxy coating system. The coating shall have a dry film thickness of at least 10 mils and shall consist of a prime (first) coat and finish coats. At least one quart of the finish coat material shall be furnished with each mixer for field touchup painting.

See the General Equipment Stipulations for other shop painting requirements.

2-8. DRIVE UNITS.

2-8.01. Electric Motors. Each propeller pump shall be driven by a submersible, electric motor manufactured and furnished by the pump manufacturer. Motor nameplate rating shall exceed the maximum power required by the pump over the operating range. Each motor shall be rated for the power supply provided to the pump, and shall have a service factor of 1.10. The stator housing shall be an air-filled, watertight casing. A cooling jacket shall encase the motor housing for each pump where needed to maintain adequate cooling. The cooling jacket shall require no external source of cooling water. Motor insulation shall be moisture resistant, Class F, 155°C. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature, and designed for at least 10 starts per hour.

The motor bearings shall be antifriction, permanently lubricated type. The bearings shall have a calculated ABMA L_{10} Life Rating of 40,000 hours when operating at maximum operating point. Maximum shaft run-out at the mechanical seals shall not exceed 2 mils at any point in the operating range.

The water seal design for cable entry shall not require a specific fastener torque to ensure a watertight and submersible seal. The use of epoxies, silicones, or other secondary sealing systems will not be acceptable. The cable entry junction box and motor shall be separated by a stator lead sealing gland or terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

Each pump shall be provided with a separate or combined submersible power cable and submersible control cable. The power cable shall contain a ground conductor and one conductor per power phase. All submersible cables shall have a legend or code permanently embossed on the cable indicating the cable is suitable for submersible use. Cable sizing shall conform to NEC requirements.

The cable lengths shall be sufficient to extend to the junction boxes specified

below plus an extra 10 feet. Each cable shall be provided with stainless steel Kellems grips and stainless steel support brackets to help prevent damage to the cable insulation.

Motors shall be specifically selected for service with an adjustable frequency type speed controller and shall be derated to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation so that the motor does not exceed Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by adjustable frequency drives shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

2-8.02. Variable Frequency Drives. Not used.

2-9. MOTOR CONTROLS.

2-9.01. Junction Box. Each pump shall be provided with a junction box for power and control cable termination. The junction box shall be mounted as indicated on the Drawings. The power and control cables to the pump shall be terminated in the junction box. A Kellems grip or other suitable strain relief device shall be provided on each submersible cable to prevent excess strain between the submersible cable and the junction box.

The junction box shall be as specified in the Electrical section.

2-9.02. Moisture Detection System. Each submersible pump housing shall be provided with a moisture detection system complete with all sensors, control power transformers if required, and relays. The moisture detection system shall be rated for a 120-volt ac supply voltage. If the system operates on a voltage other than 120 volt ac, the manufacturer shall provide the necessary control power transformer. The moisture detection system shall provide one normally open dry output contact rated 5 amps at 120 volts ac. The contact shall close when moisture is detected in the submersible pump motor housing or motor pre-chamber as recommended by the equipment manufacturer. All moisture detection system components shall be furnished by the submersible pump supplier and components not integral to the pump shall be shipped loose for installation into the motor controller enclosure.

2-9.03. Temperature Detection System. Each motor shall be protected by one motor temperature switch embedded in each phase winding. Each switch shall be designed to operate at 125°C (±5°C). Each switch shall be normally closed automatic reset type rated 5 amps at 120 V ac. The switches shall be wired in series with end leads wired to terminals within the motor housing.

PART 3 - EXECUTION

3-1. INSTALLATION. Each unit shall be installed in accordance with Equipment Installation section and as specified herein.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily and in accordance with the specified performance requirements.

All costs for these services shall be included in the contract price.

3-3. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-3.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-3.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training..

End of Section

Section 43 40 40

LIQUID CHEMICAL FEED SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers liquid chemical feed equipment and accessories. Principal items to be furnished and installed shall include the following:

Sodium Hypochlorite Feed System.

One quick connect adapter.
One strainer.
Seven installed metering pumps with integral control panels
Seven calibration columns.
Seven chemical diffusers.
One back-pressure valve per pump required (ship loose)

Sodium Hydroxide Feed System.

One quick connect adapter.
Three metering pumps with integral control panels.
Three calibration columns.
Three chemical diffusers.
One back-pressure valve per pump required (ship loose)

Sodium Bisulfite Feed System.

Two containment with integral scale.
Two quick connect coupler.
One metering pump with integral control panel.
One calibration column.
One chemical diffuser.
One back-pressure valve per pump required (ship loose)

Antiscalant Feed System.

Two containment with integral scale.
Two quick connect coupler.
One metering pump with integral control panel.
One calibration column.
One chemical diffuser.
One back-pressure valve per pump required (ship loose)

Citric Acid Feed System.

Two containment with integral scale.
Two quick connect coupler.
Two metering pumps with integral control panels.
One calibration column.
Two chemical diffusers.
One back-pressure valve per pump required (ship loose)

Sulfuric Acid Feed System.

Two containment with integral scale.
Two quick connect coupler.
Two metering pumps.
One calibration column.
One sulfuric acid dilution panel.
Two chemical diffusers.
One back-pressure valve per pump required (ship loose)

Liquid Ammonia Sulfate.

Two containment with integral scale.
Two quick connect coupler.
One metering pump.
One calibration column.
One chemical diffuser.
One back-pressure valve per pump required (ship loose)

The following items of work and equipment are covered under other sections:

Piping and valves between items of equipment.
Water supply and electric power supply to the equipment.
Drain and vent piping.

1-2. SYSTEM INTEGRATOR. The chemical feed systems shall be designed, coordinated, and supplied by a competent System Integrator. The System Integrator shall be regularly engaged in the business of designing and assembling liquid chemical feed systems for water treatment or wastewater treatment plant projects. The System Integrator shall be responsible for ensuring that a complete functioning system is supplied for each Chemical Feed System. The System Integrator shall be responsible for coordinating all equipment, piping, and valves, and appurtenances for each Chemical Feed System.

1-2.01. System Integrator Qualifications. The System Integrator shall meet all of the following requirements and within 30 days after the Notice of Award, the System Integrator shall submit proof of the following qualifications for the intended System Integrator:

The System Integrator has successfully provided similar work for at least 5 years.

The names of at least three references who are users of similar systems designed, assembled, and furnished by the System Integrator.

The System Integrator has the required financial capability.

The names of manufacturers whose products will be supplied.

The System Integrator maintains a qualified technical staff and design office.

The System Integrator has the physical plant and fabricating personnel to complete the work specified.

The System Integrator has and will maintain competent service personnel to service the equipment furnished.

1-3. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Design-Builder.

Each item shall be furnished and installed complete with all mechanical and electrical equipment required for proper operation, all components indicated on the drawings or specified, and all additional materials or construction required by the design of the system.

1-3.01. Coordination. The System Integrator shall verify that each system component is compatible and consistent with all other components of the system, that all pipe materials and sizes are appropriate, and that all devices necessary for a properly functioning system have been provided. Devices and appurtenances necessary for a properly functioning system shall be constructed of materials consistent with the piping materials unless otherwise indicated. The System Integrator shall assume responsibility for ensuring that Minimum Suction Head and NPSH available is adequate for the supplied pumps.

Similar components of different chemical feed systems shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

Review of drawings submitted prior to the final determination and coordination of related equipment to be provided will not relieve the System Integrator from responsibility for supplying systems in full compliance with the specific requirements of the related equipment.

1-3.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. Piping on skids shall be constructed consistent with the piping and valve specifications.

1-3.03. Governing Standards. All electrical equipment shall conform to applicable standards of the National Electrical Manufacturers Association and the National Electrical Code.

1-3.04. Power Supply. Unless otherwise specified, the power supply will be 120 volts, 60 Hz, single phase. Where control voltage lower than the power supply voltage is required, a suitable control power transformer shall be furnished. Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

1-3.05. Metal Thicknesses. Metal thicknesses and gauges specified herein are the minimum required. Gauges refer to US Standard gauge.

1-3.06. Nameplates. A nameplate shall be provided and mounted on or adjacent to each piece of chemical feed equipment to identify its function. Nameplates shall be approximately 1 by 3 inches, made from black on white phenolic material. Letters shall be engraved to the white interior and shall be at least 3/16-inch high. Feeder designations on the nameplates shall correspond to those indicated on the drawings.

1-3.07. Spare Parts. A list of recommended spare parts with pricing shall be furnished during the submittal phase.

1-4. SUBMITTALS. Submittals for chemical feed systems shall have the following organization and information as a minimum.

1-4.01. Submittal Organization. The submittal shall be split up into different sections with a separate section for each chemical feed system. Each system section shall be supplied with the following information.

System Integrator Name, Contact Name, Phone Number, Address, and email address.

System Integrator Contact Name Qualifications and Experience

Bill of Materials

System piping and instrumentation diagram (P&ID) with legend

Equipment and piping layout starting from bulk storage tank pump suction nozzle to discharge of anti-siphon loop.

Tote scale and pallet selection

Strainer selection

Metering pump selections

Metering pump appurtenances including calibration column

Control Panel layout and wiring diagram.

Diffuser selection.

Control narrative.

Spare parts

1-4.02. Drawings and Data. Complete fabrication, assembly, installation and equipment and piping layout drawings, piping and instrumentation diagrams, and wiring diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Section.

1-4.03. Calibration Graphs. The System Integrator shall prepare a calibration graph from field tests for each chemical feed pump. Each graph shall include a family of curves of pump speed/stroke length versus gallons per hour at 25, 50, 75 and 100 percent speed and 10, 25, 50, 75, and 100 percent stroke length. Each graph shall be furnished on hard paper and sealed in clear plastic.

1-4.04. Control Narrative. A narrative description of the proposed metering pump controls, including all control modes, manual and automatic operations, electrical interlocks, alarms, and interfaces to the Plant Control System shall be submitted.

1-4.05. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied and shall be submitted in accordance with the submittals section. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

a. Equipment function, normal operating characteristics, and limiting conditions.

b. Assembly, installation, alignment, adjustment, and checking instructions.

c. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

d. Lubrication and maintenance instructions.

e. Guide to troubleshooting.

f. Parts lists and predicted life of parts subject to wear.

g. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

h. Test data and performance curves, where applicable.

i. A listing of all filter locations, type, size, and quantity associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2-1. SYSTEM INTEGRATOR. The chemical feed system shall be coordinated and supplied by a qualified System Integrator who is regularly engaged in the business of designing and assembling liquid chemical feed systems for water treatment or wastewater treatment plant projects.

2-2. CONSTRUCTION. Chemical feed equipment shall be of substantial construction with all parts designed for long life under working conditions including corrosive atmospheres and intermittent or continuous operation. All wearing parts and items requiring adjustment shall be readily accessible. Each unit shall be completely enclosed and dust tight when in operation. All parts which are exposed to corrosive conditions shall be made from corrosion-resistant materials or covered with suitable protective coatings.

2-3. SODIUM HYPOCHLORITE FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense Sodium Hypochlorite to the following feed points:

- Ocean Outfall
- RO Concentrate Water

- RO Feed
- UV AOP System
- RO Product Water
- MBR Backwash/CIP
- Recycled Water Pumps

2-3.01. Quick Connect Adapter. One quick connect adapter shall be provided at the truck unloading station to connect the truck's hose to the storage tank fill line as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the adapter type (grooved fitting) with a locking dust cap. The adapter shall be constructed of material suitable for the chemical service with female NPT threads for connecting to the fill piping. The adapters shall be the same size as the storage tank fill line as indicated on the drawings. The quick connect adapters shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, or equal.

2-3.02. Strainer. One transparent PVC bodied Y-pattern strainer with 12-mesh screen and Viton O-ring seals shall be provided on the suction side of the metering pump skids.

2-3.03. Metering Pump Skids. Two metering pump skids shall be furnished and installed as indicated on the drawings to dispense 12.5 percent sodium hypochlorite with a specific gravity of 1.18 to the points of application. Each skid shall be located in the Chemical Facility.

Skid No. 1 shall have three metering pumps on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and a control panel. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams. Skid No. 1 shall have a footprint no larger than 2'-6" by 4'-6".

Skid No. 2 shall have four metering pumps on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and a control panel. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams. Skid No. 2 shall have a footprint no larger than 2'-6" by 6'-0".

All power and control wiring within each skid shall be provided by the System Integrator such that the skid requires connection of a single primary 120V power circuit.

Each skid shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that

there is unobstructed access to the controls, pump head, and pump check valves. Valves and appurtenances shall be within easy reach from the skid edge.

Piping on the skids shall be consistent with specification the Miscellaneous Plastic Piping Section. Valves shall be type VD-1 consistent with the Pinch Valves and Diaphragm Valves Section. Valves shall be labeled with valve numbers shown on the piping and instruments diagrams.

2-3.03.01. Metering Pumps. Seven metering pumps shall be furnished and installed on the skid as indicated on the drawings to dispense 12.5 percent sodium hypochlorite with a specific gravity of 1.18 to the feed points as listed below.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below.

Feed point	Ocean Outfall	RO Concentrate Water	RO Feed	UV AOP System	RO Product Water	MBR Backwash / CIP	Recycled Water Pumps
Tag No.	90-NOCL-P-0101	90-NOCL-P-0201	90-NOCL-P-0301	90-NOCL-P-0401	90-NOCL-P-0501	90-NOCL-P-0601	90-NOCL-P-0701
Skid No.	1	1	1	2	2	2	2
Installed pump quantity	One	One	One	One	One	One	One
Capacity control range, percent	0 - 100	0 - 100	0 - 100	0 - 100	0 - 100	0 - 100	0 - 100
Metering range, gph	0.6 - 65	0.04 - 0.63	0.6 - 4.6	0.2 - 1.3	0.01 - 0.32	158	0.01 - 0.11
Maximum speed, rpm	225	225	225	225	225	225	225
Nominal discharge pressure, psi	30	30	30	30	30	30	30

Pumps shall be positive displacement, tube-type peristaltic, case-drive pumps complete with retractable roller pump head, rotor assembly with a minimum of two compression rollers, self-contained variable speed drive, flexible extruded tube, and integral key pad control panel.

The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be constructed of material chemically resistant to the pumped solution, as acceptable to the Design-Builder. The pump shall be capable of accepting at least five tube diameters to increase capacity range. The tubing shall have a minimum wall thickness of 1.5 mm. A 50-foot section of tubing shall be provided for each pump or a total of ten spare replacement tubing assemblies shall be provided.

The pump head shall consist of a fixed track, hinged transparent guard door or removable transparent cover with lock and magnetic safety interlock and two roller rotor assemblies. The door and safety interlock shall render the drive inoperable when the door is open. Conversely, a removable cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 rpm when removed.

The tubing shall be in contact with the inside diameter of a fixed track (housing) through an angle of 180º and shall be held in place on the suction and discharge by the clamp mechanisms or pump tube assembly connection fittings. Tube clamps requiring tools will not be acceptable. Tubing replacement shall not require the use of tools.

Rotor assembly shall be equipped with a minimum of two 316 SS or polymeric compression rollers and SS bearings or two polymeric compression rollers and encapsulated SS bearings. Compression rollers shall be located a maximum of 180 degrees apart for compression of the tube against the track a minimum of twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Tube occlusion or spring tension shall be factory set for the tubing wall thickness and shall not require additional adjustment for other tubing sizes. The rotor assembly shall be securely attached to the output shaft of the drive gear motor by the manufacturer's standard assembly for that model.

The self-contained variable speed drive for each pump shall be fully operational over the entire flow range requirements indicated above. Additionally, the pumps shall be fully capable of the discharge back pressure required above. Pumps and drives shall be suitable for continuous 24-hour operation at the conditions specified.

Each pump shall be completely self-priming with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and check valves. Flow through the hose shall be in the direction of the rotor rotation and the motor shall be capable of being fully reversed.

Each installed pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and

branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One pressure gauge and pressure switch with isolating diaphragm in each pump discharge piping arrangement. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The isolating diaphragm shall protect the pressure gauge from the chemical solution. The pressure-switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches shall have weatherproof housings. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or Viton and the connection port shall be stainless steel. All stem-mounted switches shall be provided with ½-inch NPT connections. All pressure switches shall be ranged in psi. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

One external relief valve sized to pass the maximum displacement of the pump.

One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

Leak detection system that shall detect a tubing failure by sensing the presence of liquid inside of the pump head with output signal for remote alarm.

Metering pumps shall be Watson-Marlow “Model 520 Series" or Blue & White “M-4 Series” without exception.

2-3.03.01. Metering Pump Drive Units. The pump shall be supplied with a case-drive integral reversible servo permanent magnet dc drive motor with internal gearbox to accept 120 volts ac, 60 Hz, single phase. Housing shall be pressure cast aluminum with a corrosion resistant powder coat. Unpainted housings, including 316SS, shall not be acceptable. Each pump shall not consume in excess of 790 VA. Drive unit shall be classified for continuous heavy shock duty, AGMA. Each drive unit shall be furnished with a grounded power cord and plug suitable for plugging into a standard grounded 120-volt receptacle. Power cord conductor size shall be #12 AWG minimum for both power and ground. The connection between the power cord and the drive unit shall be as recommended by the manufacturer.

The drive shall be rated Class II, 24-hour duty. Pump drive shall be closed coupled and self-aligning without requiring flexible couplings.

Drive circuitry shall be microprocessor controlled with temperature and load compensation and protection. External VFDs or SCRs shall not be acceptable.

Drive enclosure shall be NEMA 4X rated.

The drive motor shall be capable of varying the speed of the pump to deliver the metering range in gph as specified. The drive shall be provided with an “HAND-OFF-AUTO” or “REMOTE/LOCAL” control of the pump. In the “HAND” or “LOCAL” position, the pump shall run and the speed of motor shall be varied by a manual speed adjustment on the pump. In “AUTO” or “REMOTE”, the pump shall be started by a remote input dry contact. Pump speed shall be varied by a remote input 4-20 mA signal. The drive shall provide an output 4-20 mA speed signal for remote monitoring. “Running”, “In Remote” selector switch position, “High Pressure,” and “Fail” contacts shall be provided for remote monitoring. Running and fault indications shall also be provided on the pump control panel.

2-3.04. Calibration Column. Seven transparent plastic calibrating columns, shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	Ocean Outfall	RO Concentrate Water	RO Feed	UVAOP System	RO Product Water	MBR Backwash / CIP	Recycled Water Pumps
Column ID, in	2			0.75			
Skid No.	1			2			
Screwed Flow Fitting, in	0.5			0.5			
Graduated Increments, gal	0.005			0.001			
Capacity, gal	1.08			2.5			

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-3.05. Pressure Relief Valves. Pressure relief valves shall be located anywhere sodium hypochlorite can become trapped in the chemical feed piping and not less than as indicated on the drawings to protect the system from damage due to excess pressure build-up resulting from the decomposition of sodium hypochlorite.

Valves shall have adjustable relief pressure setting, with initial relief pressure set at 120 psi. The valve body shall be constructed of CPVC. All wetted materials including seats, seals and diaphragms shall be constructed of CPVC, Viton, or Teflon, as acceptable to Design-Builder. Each valve shall be supplied with a tamper proof seal, which must be broken in order to change the factory pressure setting. A tag indicating the initial pressure setting shall be provided.

Valves shall be Griffco Valve, Inc. "Pressure Relief Valves," Hydroflo Corporation "HydroGarD High Pressure Safety Relief Valves," or Plast-O-Matic “Series RVDT.”

2-3.06. Diffusers. Seven diffusers shall be provided as shown on the drawings

2-3.07. Back-Pressure Valve. One properly sized back-pressure valve per pump to be shipped loose. The back pressure valve shall be constructed of material compatible with the fluid.

2-4. SODIUM HYDROXIDE FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense Sodium Hydroxide to the following feed points:

- RO CIP/Neutralization Tank

- Product Water Tank
- Fine Screen Effluent

2-4.01. Quick Connect Adapter. One quick connect adapter shall be provided at the truck unloading station to connect the truck's hose to the storage tank fill line as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the adapter type (grooved fitting) with a locking dust cap. The adapter shall be constructed of material suitable for the chemical service with female NPT threads for connecting to the fill piping. The adapters shall be the same size as the storage tank fill line as indicated on the drawings. The quick connect adapters shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, or equal.

2-4.02. Metering Pump Skid. One metering pump skid shall be furnished and installed as indicated on the drawings to dispense 25 percent sodium hydroxide with a specific gravity of 1.25 to the points of application. The skid shall be located in the Chemical Facility. The skid shall have three metering pumps on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and a control panel. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams. All power and control wiring within the skid shall be provided by the System Integrator such that the skid requires connection of a single primary 120V power circuit.

Skids shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that there is unobstructed access to the controls, pump head, and pump check valves. Valves and appurtenances shall be within easy reach from the skid edge. The skid shall have a footprint no larger than 2'-6" by 4'-6".

Piping on the skids shall be consistent with the Miscellaneous Plastic Piping Section. Valves shall be type VB-10 consistent with the Miscellaneous Ball Valves Section. Valves shall be labeled with valve numbers shown on the piping and instruments diagrams.

One carbon steel bodied Y-pattern strainer with 12-mesh screen and Viton O-ring seals shall be provided on the skid inlet pipe, upstream of all metering pumps.

2-4.02.01. Metering Pumps. Three metering pumps shall be furnished and installed on the skid as indicated on the drawings to dispense 25 percent sodium hydroxide with a specific gravity of 1.25 to the feed points as listed below.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below.

Feed point	RO CIP/Neutralization Tank	Product Water Tank	Fine Screen Effluent
Designation	90-NAOH-P-0101	90-NAOH-P-0201	90-NAOH-P-0301
Installed pump quantity	One	One	One
Capacity control range, percent	0 - 100	0 - 100	0 - 100
Metering range, gph	130	0.07 - 0.21	0.1 - 9.0
Maximum speed, rpm	225	225	225
Nominal discharge pressure, psi	30	30	30

Pumps shall be positive displacement, tube-type peristaltic, case-drive pumps complete with retractable roller pump head, rotor assembly with a minimum of two compression rollers, self-contained variable speed drive, flexible extruded tube, and integral key pad control panel.

The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be constructed of material chemically resistant to the pumped solution, as acceptable to the Design-Builder. The pump shall be capable of accepting at least five tube diameters to increase capacity range. The tubing shall have a minimum wall thickness of 1.5 mm. A 50-foot section of tubing shall be provided for each pump or a total of ten spare replacement tubing assemblies shall be provided.

The pump head shall consist of a fixed track, hinged transparent guard door or removable transparent cover with lock and magnetic safety interlock and two roller rotor assemblies. The door and safety interlock shall render the drive inoperable when the door is open. Conversely, a removable cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 rpm when removed.

The tubing shall be in contact with the inside diameter of a fixed track (housing) through an angle of 180^{o} and shall be held in place on the suction and discharge by the clamp mechanisms or pump tube assembly connection fittings. Tube clamps requiring tools will not be acceptable. Tubing replacement shall not require the use of tools.

Rotor assembly shall be equipped with a minimum of two 316 SS or polymeric compression rollers and SS bearings or two polymeric compression rollers and

encapsulated SS bearings. Compression rollers shall be located a maximum of 180 degrees apart for compression of the tube against the track a minimum of twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Tube occlusion or spring tension shall be factory set for the tubing wall thickness and shall not require additional adjustment for other tubing sizes. The rotor assembly shall be securely attached to the output shaft of the drive gear motor by the manufacturer's standard assembly for that model.

The self-contained variable speed drive for each pump shall be fully operational over the entire flow range requirements indicated above. Additionally, the pumps shall be fully capable of the discharge back pressure required above. Pumps and drives shall be suitable for continuous 24-hour operation at the conditions specified.

Each pump shall be completely self-priming with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and check valves. Flow through the hose shall be in the direction of the rotor rotation and the motor shall be capable of being fully reversed.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One pressure gauge and pressure switch with isolating diaphragm in each pump discharge piping arrangement. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The isolating diaphragm shall protect the pressure gauge from the chemical solution. The pressure-switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches shall have weatherproof housings. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or viton and the connection port shall be stainless steel. All stem-mounted switches shall be provided with 1/2-inch NPT connections. All pressure switches shall be ranged in psi. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac. Switches shall be installed at the locations

indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

One external relief valve sized to pass the maximum displacement of the pump. Pressure relief valves shall be constructed of carbon steel to match the pipe.

One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

Leak detection system that shall detect a tubing failure by sensing the presence of liquid inside of the pump head with output signal for remote alarm.

Metering pumps shall be Watson-Marlow “Model 520 Series" or Blue & White “M-4 Series” without exception.

2-4.02.02. Metering Pump Drive Units. The pump shall be supplied with a case-drive integral reversible servo permanent magnet dc drive motor with internal gearbox to accept 120 volts ac, 60 Hz, single phase. Housing shall be pressure cast aluminum with a corrosion resistant powder coat. Unpainted housings, including 316SS, shall not be acceptable. Each pump shall not consume in excess of 790 VA. Drive unit shall be classified for continuous heavy shock duty, AGMA. Each drive unit shall be furnished with a grounded power cord and plug suitable for plugging into a standard grounded 120-volt receptacle. Power cord conductor size shall be #12 AWG minimum for both power and ground. The connection between the power cord and the drive unit shall be as recommended by the manufacturer.

The drive shall be rated Class II, 24-hour duty. Pump drive shall be closed coupled and self-aligning without requiring flexible couplings.

Drive circuitry shall be microprocessor controlled with temperature and load compensation and protection. External VFDs or SCRs shall not be acceptable.

Drive enclosure shall be NEMA 4X rated.

The drive motor shall be capable of varying the speed of the pump to deliver the metering range in gph as specified. The drive shall be provided with an “HAND-OFF-AUTO” or “REMOTE/LOCAL” control of the pump. In the “HAND” or “LOCAL” position, the pump shall run and the speed of motor shall be varied by a manual speed adjustment on the pump. In “AUTO” or “REMOTE”, the pump shall be started by a remote input dry contact. Pump speed shall be varied by a remote input 4-20 mA signal. The drive shall provide an output 4-20 mA speed signal for remote monitoring. “Running”, “In Remote” selector switch position, “High Pressure,” and “Fail” contacts shall be provided for remote monitoring. Running and fault indications shall also be provided on the pump control panel.

2-4.03. Calibration Columns. Three transparent plastic calibrating columns shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	RO CIP/Neutralization Tank	Product Water Tank	Fine Screen Effluent
Column ID, in	0.5		
Screwed Flow Fitting, in	0.5		
Graduated Increments, gal	0.0005		
Capacity, gal	2.17		

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-4.04. Diffusers. Three diffusers shall be provided as shown on the drawings.

2-4.05. Back-Pressure valve: One properly sized back-pressure valve per pump to be shipped loose. The back pressure valve shall be constructed of material compatible with the fluid.

2-5. SODIUM BISULFITE FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense Sodium Bisulfite to the following feed points:

- Dechlorination to Ocean Outfall

2-5.01. Tote and Containment Level Measurement. Two containment pallet and scale shall be furnished and installed in the sodium bisulfite chemical tote storage area as shown on the drawings. This unit can be either a single assemblage as shown on the P&IDs or individual pieces. The single assemblage shall be Scaletron Industries, LTD model “4042-63 IBC” or equal. If individual pieces are used, the equipment shall be verified to fit within the space available.

2-5.01.01. Tote Containment. Each containment pallet shall have a capacity of 400 gallons and shall include a platform that can support totes measuring 38 to 50 inches in width. The maximum load capacity shall be 10,000 pounds and the pallet shall be constructed of polyethylene. Provisions shall be included to drain the pallet of rainwater.

Pallets shall be Interstate Products, Inc. “1680 IBC Spill Unit”, Scaletron Industries, Ltd. “4042-63 IBC”, or equal.

2-5.01.02. IBC Heat Blankets. Each containment pallet shall have a heat blanket capable to protect chemical from thickening or freezing.

IBC heat blanket shall be Uline H-8023 or equal.

2-5.01.02. Day Tank Scale. Two electronic load cell scale of the digital type, suitable for weighing the alum day tank, shall be furnished and installed in the chemical feed area as indicated on the drawings. The scale shall have total weighing capacity of 3,000 pounds and shall be designed for floor surface mounting. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable to indicate 0 to 3,000 pounds in 1-pound increments.

The scale shall be Eagle Microsystems "LP4200 Platform Scale" with "EI 1000 Indicator", Force Flow Equipment "Model 40-DR30LP Scale" with "Wizard 4000 Indicator", Scaletron Industries, Ltd. “Model 1099”, or equal.

2-5.02. Quick Connect Coupler. Two quick connect couplers shall be furnished and installed on the hose connections for the chemical delivery tote bin as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the coupler type with cam arms and hose shank or female NPT threads for connecting to hose or piping as indicated on the drawings. The coupler shall be the same size as the hoses or piping as indicated on the drawings. The quick connect coupler shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, without exception.

2-5.03. Metering Pump Skid. One metering pump skid shall be furnished and installed as indicated on the drawings to dispense 38 percent sodium bisulfite with a specific gravity of 1.31 to the points of application. The skid shall be located in the Chemical Facility. The skid shall have one metering pump on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and a control panel. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams. All power and control wiring within the skid shall be provided by the System Integrator such that the skid requires connection of a single primary 120V power circuit.

The skid shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that there is unobstructed access to the controls, pump head, and pump check valves. Valves and appurtenances shall be within easy reach from the skid edge. The skid shall have a footprint as determined by the System Integrator.

Piping on the skids shall be consistent with the Miscellaneous Plastic Piping Section. Valves shall be type VB-10 consistent with the Miscellaneous Ball Valves Section. Valves shall be labeled with valve numbers shown on the piping and instruments diagrams.

2-5.03.01. Metering Pumps. One metering pump shall be furnished and installed on the skid as indicated on the drawing to dispense 38 percent sodium bisulfite with a specific gravity of 1.31 to the feed points as listed below.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below.

Feed point	Ocean Outfall
Designation	90-NHS-P-0001; 90-NHS-P-0002
Installed pump quantity	Two
Capacity control range, percent	0 - 100
Metering range, gph	0.002 - 11.6
Maximum speed, rpm	225
Nominal discharge pressure, psi	30

Pumps shall be positive displacement, tube-type peristaltic, case-drive pumps complete with retractable roller pump head, rotor assembly with a minimum of two compression rollers, self-contained variable speed drive, flexible extruded tube, and integral key pad control panel.

The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be constructed of material chemically resistant to the pumped solution, as acceptable to the Design-Builder. The pump shall be capable of accepting at least five tube diameters to increase capacity range. The tubing shall have a minimum wall thickness of 1.5 mm. A 50-foot section of tubing shall be provided for each pump or a total of ten spare replacement tubing assemblies shall be provided.

The pump head shall consist of a fixed track, hinged transparent guard door or removable transparent cover with lock and magnetic safety interlock and two roller rotor assemblies. The door and safety interlock shall render the drive inoperable when the door is open. Conversely, a removable cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 rpm when removed.

The tubing shall be in contact with the inside diameter of a fixed track (housing) through an angle of 180^{o} and shall be held in place on the suction and discharge by the clamp mechanisms or pump tube assembly connection fittings. Tube clamps requiring tools will not be acceptable. Tubing replacement shall not require the use of tools.

Rotor assembly shall be equipped with a minimum of two 316 SS or polymeric compression rollers and SS bearings or two polymeric compression rollers and encapsulated SS bearings. Compression rollers shall be located a maximum of 180 degrees apart for compression of the tube against the track a minimum of twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Tube occlusion or spring tension shall be factory set for the tubing wall thickness and shall not require additional adjustment for other tubing sizes. The rotor assembly shall be securely attached to the output shaft of the drive gear motor by the manufacturer’s standard assembly for that model.

The self-contained variable speed drive for each pump shall be fully operational over the entire flow range requirements indicated above. Additionally, the pumps shall be fully capable of the discharge back pressure required above. Pumps and drives shall be suitable for continuous 24-hour operation at the conditions specified.

Each pump shall be completely self-priming with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and check valves. Flow through the hose shall be in the direction of the rotor rotation and the motor shall be capable of being fully reversed.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to

these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One transparent PVC bodied Y-pattern strainer with 12-mesh screen and Viton O-ring seals.

One pressure gauge and pressure switch with isolating diaphragm in each pump discharge piping arrangement. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The isolating diaphragm shall protect the pressure gauge from the chemical solution. The pressure-switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches shall have weatherproof housings. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or Viton and the connection port shall be stainless steel. All stem-mounted switches shall be provided with ½-inch NPT connections. All pressure switches shall be ranged in psi. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

One external relief valve sized to pass the maximum displacement of the pump.

One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

Leak detection system that shall detect a tubing failure by sensing the presence of liquid inside of the pump head with output signal for remote alarm.

Metering pumps shall be Watson-Marlow “Model 520 Series" or Blue & White “M-4 Series” without exception.

2-5.03.01. Metering Pump Drive Units. The pump shall be supplied with a case-drive integral reversible servo permanent magnet dc drive motor with internal gearbox to accept 120 volts ac, 60 Hz, single phase. Housing shall be pressure cast aluminum with a corrosion resistant powder coat. Unpainted housings, including 316SS, shall not be acceptable. Each pump shall not consume in excess of 790 VA. Drive unit shall be classified for continuous heavy shock duty, AGMA. Each drive unit shall be furnished with a grounded power cord and plug suitable for plugging into a standard grounded 120-volt receptacle. Power cord conductor size shall be #12 AWG minimum for both power and ground. The connection between the power cord and the drive unit shall be as recommended by the manufacturer.

The drive shall be rated Class II, 24-hour duty. Pump drive shall be closed coupled and self-aligning without requiring flexible couplings.

Drive circuitry shall be microprocessor controlled with temperature and load compensation and protection. External VFDs or SCRs shall not be acceptable.

Drive enclosure shall be NEMA 4X rated.

The drive motor shall be capable of varying the speed of the pump to deliver the metering range in gph as specified. The drive shall be provided with an “HAND-OFF-AUTO” or “REMOTE/LOCAL” control of the pump. In the “HAND” or “LOCAL” position, the pump shall run and the speed of motor shall be varied by a manual speed adjustment on the pump. In “AUTO” or “REMOTE”, the pump shall be started by a remote input dry contact. Pump speed shall be varied by a remote input 4-20 mA signal. The drive shall provide an output 4-20 mA speed signal for remote monitoring. “Running”, “In Remote” selector switch position, “High Pressure,” and “Fail” contacts shall be provided for remote monitoring. Running and fault indications shall also be provided on the pump control panel.

2-5.04. Calibration Column. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	Ocean Outfall
Column ID, in	0.5
Screwed Flow Fitting, in	0.5
Graduated Increments, gal	0
Capacity, gal	0.2

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-5.05. Diffuser. One diffuser shall be provided as shown on the drawings.

2-5.06. Back-Pressure Valve. One properly sized back-pressure valve per pump to be shipped loose. The back pressure valve shall be constructed of material compatible with the fluid.

2-6. ANTISCALANT FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense Antiscalant to the following feed points:

- Common RO Header

2-6.01. Tote and containment Level Measurement. Two containment pallet and scale shall be furnished and installed in the antiscalant chemical tote storage area as shown on the drawings. This unit can be either a single assemblage as shown on the P&IDs or individual pieces. The single assemblage shall be Scaletron Industries, LTD model “4042-63 IBC” or equal. If individual pieces are used, the equipment shall be verified to fit within the space available.

2-6.01.01. Tote Containment. Each containment pallet shall have a capacity of 400 gallons and shall include a platform that can support totes measuring 38 to 50 inches in width. The maximum load capacity shall be 10,000 pounds and the pallet shall be constructed of polyethylene. Provisions shall be included to drain the pallet of rainwater.

Pallets shall be Interstate Products, Inc. “1680 IBC Spill Unit”, Scaletron Industries, Ltd. “4042-63 IBC”, or equal.

2-6.01.02. Day Tank Scale. Two electronic load cell scale of the digital type, suitable for weighing the alum day tank, shall be furnished and installed in the chemical feed area as indicated on the drawings. The scale shall have total weighing capacity of 3,000 pounds and shall be designed for floor surface mounting. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The

indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable to indicate 0 to 3,000 pounds in 1-pound increments.

The scale shall be Eagle Microsystems "LP4200 Platform Scale" with "EI 1000 Indicator", Force Flow Equipment "Model 40-DR30LP Scale" with "Wizard 4000 Indicator", Scaletron Industries, Ltd. “Model 1099”, or equal.

2-6.02. Quick Connect Coupler. Two quick connect couplers shall be furnished and installed on the hose connections for the chemical delivery tote bin as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the coupler type with cam arms and hose shank or female NPT threads for connecting to hose or piping as indicated on the drawings. The coupler shall be the same size as the hoses or piping as indicated on the drawings. The quick connect coupler shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, without exception.

2-6.03. Metering Pump Skids. One metering pump skid shall be furnished and installed as indicated on the drawings to dispense 100 percent antiscalant with a specific gravity of 1.12 to the points of application. The skid shall be located in the chemical building. The skid shall have onemetering pumps on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and a control panel. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams. Each skid shall have a dedicated control panel, and all power and control wiring within the skid shall be provided by the System Integrator such that the skid requires connection of a single primary 120V power circuit.

Skids shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that there is unobstructed access to the controls, pump head, and pump check valves. Valves and appurtenances shall be within easy reach from the skid edge. The skid shall have a footprint as determined by the System Integrator.

Piping on the skids shall be consistent with the Miscellaneous Plastic Piping Section. Valves shall be type VB-10 consistent with the Miscellaneous Ball Valves Section. Valves shall be labeled with valve numbers shown on the piping and instruments diagrams.

2-6.04. Metering Pumps. One metering pump shall be furnished and installed on the skid as indicated on the drawing to dispense 100 percent antiscalant with a specific gravity of 1.12 to the feed points as listed below.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below.

Feed point	Common RO Header
Designation	90-ANTI-P-0001
Installed pump quantity	One
Capacity control range, percent	0 - 100
Metering range, gph	0.02 - 0.21
Maximum speed, rpm	225
Nominal discharge pressure, psi	30

Pumps shall be positive displacement, tube-type peristaltic, case-drive pumps complete with retractable roller pump head, rotor assembly with a minimum of two compression rollers, self-contained variable speed drive, flexible extruded tube, and integral key pad control panel.

The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be constructed of material chemically resistant to the pumped solution, as acceptable to the Design-Builder. The pump shall be capable of accepting at least five tube diameters to increase capacity range. The tubing shall have a minimum wall thickness of 1.5 mm. A 50-foot section of tubing shall be provided for each pump or a total of ten spare replacement tubing assemblies shall be provided.

The pump head shall consist of a fixed track, hinged transparent guard door or removable transparent cover with lock and magnetic safety interlock and two roller rotor assemblies. The door and safety interlock shall render the drive inoperable when the door is open. Conversely, a removable cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 rpm when removed.

The tubing shall be in contact with the inside diameter of a fixed track (housing) through an angle of 180^{o} and shall be held in place on the suction and discharge by the clamp mechanisms or pump tube assembly connection fittings. Tube clamps requiring tools will not be acceptable. Tubing replacement shall not require the use of tools.

Rotor assembly shall be equipped with a minimum of two 316 SS or polymeric compression rollers and SS bearings or two polymeric compression rollers and encapsulated SS bearings. Compression rollers shall be located a maximum of 180 degrees apart for compression of the tube against the track a minimum of twice per rotor revolution. One roller shall at all times be fully engaged with the

tubing providing complete compression to prevent backflow or siphoning. Tube occlusion or spring tension shall be factory set for the tubing wall thickness and shall not require additional adjustment for other tubing sizes. The rotor assembly shall be securely attached to the output shaft of the drive gear motor by the manufacturer's standard assembly for that model.

The self-contained variable speed drive for each pump shall be fully operational over the entire flow range requirements indicated above. Additionally, the pumps shall be fully capable of the discharge back pressure required above. Pumps and drives shall be suitable for continuous 24-hour operation at the conditions specified.

Each pump shall be completely self-priming with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and check valves. Flow through the hose shall be in the direction of the rotor rotation and the motor shall be capable of being fully reversed.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One transparent PVC bodied Y-pattern strainer with 12-mesh screen and Viton O-ring seals.

One pressure gauge and pressure switch with isolating diaphragm in each pump discharge piping arrangement. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The isolating diaphragm shall protect the pressure gauge from the chemical solution. The pressure-switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches shall have weatherproof housings. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or viton and the connection port shall be stainless steel. All stem-mounted switches shall be provided with 1/2-inch NPT connections. All pressure switches shall be ranged in psi. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation

details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

One external relief valve sized to pass the maximum displacement of the pump.

One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

Leak detection system that shall detect a tubing failure by sensing the presence of liquid inside of the pump head with output signal for remote alarm.

Metering pumps shall be Watson-Marlow “Model 520 Series" or Blue & White “M-4 Series” without exception.

2-6.03.01. Metering Pump Drive Units. The pump shall be supplied with a case-drive integral reversible servo permanent magnet dc drive motor with internal gearbox to accept 120 volts ac, 60 Hz, single phase. Housing shall be pressure cast aluminum with a corrosion resistant powder coat. Unpainted housings, including 316SS, shall not be acceptable. Each pump shall not consume in excess of 790 VA. Drive unit shall be classified for continuous heavy shock duty, AGMA. Each drive unit shall be furnished with a grounded power cord and plug suitable for plugging into a standard grounded 120-volt receptacle. Power cord conductor size shall be #12 AWG minimum for both power and ground. The connection between the power cord and the drive unit shall be as recommended by the manufacturer.

The drive shall be rated Class II, 24-hour duty. Pump drive shall be closed coupled and self-aligning without requiring flexible couplings.

Drive circuitry shall be microprocessor controlled with temperature and load compensation and protection. External VFDs or SCRs shall not be acceptable.

Drive enclosure shall be NEMA 4X rated.

The drive motor shall be capable of varying the speed of the pump to deliver the metering range in gph as specified. The drive shall be provided with an “HAND-OFF-AUTO” or “REMOTE/LOCAL” control of the pump. In the “HAND” or “LOCAL” position, the pump shall run and the speed of motor shall be varied by a manual speed adjustment on the pump. In “AUTO” or “REMOTE”, the pump shall be started by a remote input dry contact. Pump speed shall be varied by a remote input 4-20 mA signal. The drive shall provide an output 4-20 mA speed signal for remote monitoring. “Running”, “In Remote” selector switch position, “High Pressure,” and “Fail” contacts shall be provided for remote monitoring. Running and fault indications shall also be provided on the pump control panel.

2-6.04. Calibration Column. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	Common RO Header
Column ID, in	0.5
Screwed Flow Fitting, in	0.5
Graduated Increments, gal	0.005
Capacity, gal	0.004

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-6.05. Diffuser. One diffuser shall be provided as shown on the drawings.

2-6.06. Back-Pressure valve: One properly sized back-pressure valve per pump to be shipped loose. The back pressure valve shall be constructed of material compatible with the fluid.

2-7. CITRIC ACID FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense citric acid to the following feed points:

- RO CIP System
- MBR Maintenance

2-7.01. Tote and containment Level Measurement. Two containment pallet and scale shall be furnished and installed in the citric acid chemical tote storage area

as shown on drawing 90-I-006. This unit can be either a single assemblage as shown on the P&IDs or individual pieces. The single assemblage shall be Scaletron Industries, LTD model “4042-63 IBC” or equal. If individual pieces are used, the equipment shall be verified to fit within the space available.

2-7.01.01. Tote Containment. Each containment pallet shall have a capacity of 400 gallons and shall include a platform that can support totes measuring 38 to 50 inches in width. The maximum load capacity shall be 10,000 pounds and the pallet shall be constructed of polyethylene. Provisions shall be included to drain the pallet of rainwater.

Pallets shall be Interstate Products, Inc. “1680 IBC Spill Unit”, Scaletron Industries, Ltd. “4042-63 IBC”, or equal.

2-7.01.02. Day Tank Scale. Two electronic load cell scale of the digital type, suitable for weighing the alum day tank, shall be furnished and installed in the chemical feed area as indicated on the drawings. The scale shall have total weighing capacity of 3,000 pounds and shall be designed for floor surface mounting. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable to indicate 0 to 3,000 pounds in 1-pound increments.

The scale shall be Eagle Microsystems "LP4200 Platform Scale" with "EI 1000 Indicator", Force Flow Equipment "Model 40-DR30LP Scale" with "Wizard 4000 Indicator", Scaletron Industries, Ltd. “Model 1099”, or equal.

2-7.02. Quick Connect Coupler. Two quick connect coupler shall be furnished and installed on the hose connections for the chemical delivery tote bin as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the coupler type with cam arms and hose shank or female NPT threads for connecting to hose or piping as indicated on the drawings. The coupler shall be the same size as the hoses or piping as indicated on the drawings. The quick connect coupler shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, without exception.

2-7.03. Metering Pump Skid. One metering pump skid shall be furnished and installed as indicated on the drawings to dispense 50 percent citric acid with a specific gravity of 1.24 to the points of application. The skid shall be located in the Chemical Facility. The skid shall have two metering pumps on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and control panels. The piping requirements, valving, and appurtenances shall be as shown

on the piping and instrument diagrams. All power and control wiring within the skid shall be provided by the System Integrator such that the skid requires connection of a single primary 120V power circuit.

Skids shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that there is unobstructed access to the controls, pump head, and pump check valves. Valves and appurtenances shall be within easy reach from the skid edge. The skid shall have a footprint as determined by the System Integrator.

Piping on the skids shall be consistent with the Miscellaneous Plastic Piping Section. Valves shall be type VB-10 consistent with the Miscellaneous Ball Valves Section. Valves shall be labeled with valve numbers shown on the piping and instruments diagrams.

One transparent PVC bodied Y-pattern strainer with 12-mesh screen and Viton O-ring seals shall be provided on the skid inlet pipe, upstream of all metering pumps.

2-7.03.01. Metering Pumps. Two metering pumps shall be furnished and installed on the skid as indicated on the drawing to dispense 50 percent citric acid with a specific gravity of 1.24 to the feed points as listed below.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below.

Feed point	RO CIP System	MBR Maintenance
Designation	90-CA-P-0101	90-CA-P-0201
Installed pump quantity	One	One
Capacity control range, percent	0 - 100	0 - 100
Metering range, gph	105	0.06 -150
Maximum speed, rpm	225	225
Nominal discharge pressure, psi	30	30

Pumps shall be positive displacement, tube-type peristaltic, case-drive pumps complete with retractable roller pump head, rotor assembly with a minimum of two compression rollers, self-contained variable speed drive, flexible extruded tube, and integral key pad control panel.

The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be constructed of material chemically resistant to the pumped

solution, as acceptable to the Design-Builder. The pump shall be capable of accepting at least five tube diameters to increase capacity range. The tubing shall have a minimum wall thickness of 1.5 mm. A 50-foot section of tubing shall be provided for each pump or a total of ten spare replacement tubing assemblies shall be provided.

The pump head shall consist of a fixed track, hinged transparent guard door or removable transparent cover with lock and magnetic safety interlock and two roller rotor assemblies. The door and safety interlock shall render the drive inoperable when the door is open. Conversely, a removable cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 rpm when removed.

The tubing shall be in contact with the inside diameter of a fixed track (housing) through an angle of 180^{o} and shall be held in place on the suction and discharge by the clamp mechanisms or pump tube assembly connection fittings. Tube clamps requiring tools will not be acceptable. Tubing replacement shall not require the use of tools.

Rotor assembly shall be equipped with a minimum of two 316 SS or polymeric compression rollers and SS bearings or two polymeric compression rollers and encapsulated SS bearings. Compression rollers shall be located a maximum of 180 degrees apart for compression of the tube against the track a minimum of twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Tube occlusion or spring tension shall be factory set for the tubing wall thickness and shall not require additional adjustment for other tubing sizes. The rotor assembly shall be securely attached to the output shaft of the drive gear motor by the manufacturer's standard assembly for that model.

The self-contained variable speed drive for each pump shall be fully operational over the entire flow range requirements indicated above. Additionally, the pumps shall be fully capable of the discharge back pressure required above. Pumps and drives shall be suitable for continuous 24-hour operation at the conditions specified.

Each pump shall be completely self-priming with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and check valves. Flow through the hose shall be in the direction of the rotor rotation and the motor shall be capable of being fully reversed.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One pressure gauge and pressure switch with isolating diaphragm in each pump discharge piping arrangement. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The isolating diaphragm shall protect the pressure gauge from the chemical solution. The pressure-switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches shall have weatherproof housings. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or Viton and the connection port shall be stainless steel. All stem-mounted switches shall be provided with ½-inch NPT connections. All pressure switches shall be ranged in psi. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

One external relief valve sized to pass the maximum displacement of the pump.

One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

Leak detection system that shall detect a tubing failure by sensing the presence of liquid inside of the pump head with output signal for remote alarm.

Metering pumps shall be Watson-Marlow “Model 520 Series" or Blue & White “M-4 Series” without exception.

2-7.03.02. Metering Pump Drive Units. Each pump shall be supplied with a case-drive integral reversible servo permanent magnet dc drive motor with internal gearbox to accept 120 volts ac, 60 Hz, single phase. Housing shall be pressure cast aluminum with a corrosion resistant powder coat. Unpainted housings, including 316SS, shall not be acceptable. Each pump shall not consume in excess of 790 VA. Drive unit shall be classified for continuous heavy shock duty, AGMA. Each drive unit shall be furnished with a grounded power cord and plug suitable for plugging into a standard grounded 120-volt receptacle. Power cord conductor size shall be #12 AWG minimum for both power and ground. The connection between the power cord and the drive unit shall be as recommended by the manufacturer.

The drive shall be rated Class II, 24-hour duty. Pump drive shall be closed coupled and self-aligning without requiring flexible couplings.

Drive circuitry shall be microprocessor controlled with temperature and load compensation and protection. External VFDs or SCRs shall not be acceptable.

Drive enclosure shall be NEMA 4X rated.

The drive motor shall be capable of varying the speed of the pump to deliver the metering range in gph as specified. The drive shall be provided with an “HAND-OFF-AUTO” or “REMOTE/LOCAL” control of the pump. In the “HAND” or “LOCAL” position, the pump shall run and the speed of motor shall be varied by a manual speed adjustment on the pump. In “AUTO” or “REMOTE”, the pump shall be started by a remote input dry contact. Pump speed shall be varied by a remote input 4-20 mA signal. The drive shall provide an output 4-20 mA speed signal for remote monitoring. “Running”, “In Remote” selector switch position, “High Pressure,” and “Fail” contacts shall be provided for remote monitoring. Running and fault indications shall also be provided on the pump control panel.

2-7.04. Calibration Columns. Two transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	RO CIP System	MBR Maintenance
Column ID, in	6	
Screwed Flow Fitting, in	1	
Graduated Increments, gal	0.05	
Capacity, gal	2.7	

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-7.05. Diffusers. Two diffusers shall be provided as shown on the drawings.

2-7.06. Back-Pressure valve: One properly sized back-pressure valve per pump to be shipped loose. The back pressure valve shall be constructed of material compatible with the fluid.

2-8. SULFURIC ACID FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense sulfuric acid to the following feed points:

- RO Feed Tank Outlet
- UV/AOP System

2-8.01. Tote and containment Level Measurement. Two containment pallet and scale shall be furnished and installed in the citric acid chemical tote storage area as shown on drawing 90-I-006. This unit can be either a single assemblage as shown on the P&IDs or individual pieces. The single assemblage shall be Scaletron Industries, LTD model “4042-63 IBC” or equal. If individual pieces are used, the equipment shall be verified to fit within the space available.

2-8.01.01. Tote Containment. Each containment pallet shall have a capacity of 400 gallons and shall include a platform that can support totes measuring 38 to 50 inches in width. The maximum load capacity shall be 10,000 pounds and the pallet shall be constructed of polyethylene. Provisions shall be included to drain the pallet of rainwater.

Pallets shall be Interstate Products, Inc. “1680 IBC Spill Unit”, Scaletron Industries, Ltd. “4042-63 IBC”, or equal.

2-8.01.02. Day Tank Scale. Two electronic load cell scale of the digital type, suitable for weighing the alum day tank, shall be furnished and installed in the chemical feed area as indicated on the drawings. The scale shall have total weighing capacity of 3,000 pounds and shall be designed for floor surface mounting. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable to indicate 0 to 3,000 pounds in 1-pound increments.

The scale shall be Eagle Microsystems "LP4200 Platform Scale" with "EI 1000 Indicator", Force Flow Equipment "Model 40-DR30LP Scale" with "Wizard 4000 Indicator", Scaletron Industries, Ltd. “Model 1099”, or equal.

2-8.02. Quick Connect Coupler. Two quick connect coupler shall be furnished and installed on the hose connections for the chemical delivery tote bin as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the coupler type with cam arms and hose shank or female NPT threads for connecting to hose or piping as indicated on the drawings. The coupler shall be the same size as the hoses or piping as indicated on the drawings. The quick connect coupler shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, without exception.

2-8.03. Metering Pump Skid. One metering pump skid shall be furnished and installed as indicated on the drawings to dispense 93 percent sulfuric acid with a specific gravity of 1.81 to the points of application. The skid shall be located in the Chemical Facility. The skid shall have two metering pumps on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and control panels. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams. All power and control wiring within the skid shall be provided by the System Integrator such that the skid requires connection of a single primary 120V power circuit.

Skid shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that there is unobstructed access to the controls, pump head, and pump check valves. Valves and appurtenances shall be within easy reach from the skid edge. The skid shall have a footprint as determined by the System Integerator.

Piping on the skids shall be consistent with the Miscellaneous Steel Piping Section. Valves shall be type alloy-20 body valves consistent with the Miscellaneous Ball Valves Section. Valves shall be labeled with valve numbers shown on the piping and instruments diagrams.

One Carpenter 20 bodied Y-pattern strainer with 12-mesh screen and Viton O-ring seals shall be provided on the skid inlet pipe, upstream of all metering pumps.

2-8.03.01. Metering Pumps. Two metering pumps shall be furnished and installed on the skid as indicated on the drawing to dispense 93 percent sulfuric acid with a specific gravity of 1.81 to the feed points as listed below.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below.

Feed point	RO Feed Tank Outlet	UV/AOP System
Designation	90-HSO4-P-0101	90-HSO4-P-0201
Installed pump quantity	One	One
Capacity control range, percent	0 - 100	1 - 100
Metering range, gph	0.15 - 0.84	0.01 - 0.10
Minimum drive motor, hp	0.50	0.50
Maximum stroke rate at rated conditions, spm	100	100
Accuracy, percent of scale over metering range	2	2
Minimum suction head required, psia	9.5	9.5
Nominal discharge pressure, psi	40	40

Each pump shall be of the positive displacement type using a hydraulic or mechanically actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housings.

Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable head.

Inlet and outlet check valves shall be of the single valve type, with valve housing which are removable without disassembly of the pipe fittings.

Material of construction of the pump head, check valves, and pump appurtenances shall be Carpenter 20 unless otherwise noted.

Materials of construction shall be selected for resistance to the pumped solution, as acceptable to the Design-Builder.

The rate of metering shall be changed by manually or automatically varying the stroking speed and the stroke length. Minimum flow rate shall be achieved at a stroking length not less than 10 percent and a stroking speed not less than 20 spm.

Each pump liquid end shall be equipped with a manual mechanical stroke length adjustment knob to provide capacity adjustment without the use of tools and

while the pump is running. All moving parts shall be totally enclosed and self-lubricating.

Each pump liquid end shall be equipped with an automatic stroke length controller set to operate from a remote signal. The input signal shall be 4-20 mA dc and shall be ungrounded type with an input resistance of not more than 250 ohms.

Motor horsepower for each pump shall be based on the above requirements and on the discharge back pressure required by the pump furnished. Motor shall not be less than the indicated horsepower. Power to the motor shall be provided by an SCR controlled rate controller as specified herein**.** Motor shall be supplied with a tachometer to close the loop with the variable speed drive. Power and control wiring from the controller to the motor shall be provided by the pump supplier.

Each pump motor shall be equipped with an electric speed adjustment to operate from an SCR controller. The signal input shall be 4-20 mA dc and shall be ungrounded differential type with an input resistance of not more than 250 ohms. The controller shall accept either the remote signal or a manual rate control signal at the controller, and vary the dc voltage to the motor, with feedback as required to attain the desired rate. Each controller shall operate from a 120 volt, single phase, 60 Hz power supply, and shall be mounted in a metering pump control panel as described in the Metering Pump Control Panel paragraph.

Each pump's liquid end shall include a diaphragm failure detection and alarm normally-open dry contact switch. Upon activation, the switch shall an alarm signal to the control panel which shall promptly stop the pump drive motor and activate the 'Fail' indicating light.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One pressure gauge and high pressure switch with isolating diaphragm installed in the discharge piping. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The high pressure switch shall be of the diaphragm type, shall have a weatherproof housing, shall have a trip point reliability better than 1 percent of actual pressure, and shall at minimum be SPDT rated at 10 amp at 120 VAC.

The isolating diaphragm shall protect the pressure gauge from the chemical solution.

One external pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacturer. The pressure relief valve shall be constructed of Carpenter 20.

One properly sized backpressure valve as recommended by the manufacturer. The back pressure valve shall be constructed of Carpenter 20.

One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

All wiring shall be furnished complete and ready for connection of an external power circuit.

2-8.03.02. Diaphragm Metering Pump Controls. For variable speed diaphragm metering pumps, the pump supplier shall provide a local control panel for each pump. The control panel shall house the SCR drive and control components required for operation of the metering pump as specified herein. The control panel shall be a fiberglass or 316 SS NEMA Type 4X enclosure mounted on the pump skid complete with wiring to the pump motor and other skid mounted devices. All wiring terminals shall be furnished complete and ready for connection to the external power supply, the remote pump controls, and the pump and pump mounted devices. Each control panel shall be provided with an engraved nameplate indicating the controlled unit, and nameplates for all major components contained on the panel face and within the control panel.

Control panels for variable speed diaphragm metering pumps shall have an “On-Off-Remote” switch and local speed adjustment on the panel front. When “On” is selected, the pump shall run and speed shall be adjusted using the local controls. When “Remote” is selected, run/stop control shall be by a normally open contact input to the panel, and speed control shall be by a 4-20 mA input. Indicating lights shall be provided on the panel front for “Run”, “Stopped”, and “Drive Failure”. These indicating lights shall be red, green, and amber respectively. Where a high discharge pressure switch is indicated on the drawings or specified to be provided for the pump, the pump shall shut down on high discharge pressure, and an amber “High Discharge Pressure” indicating light on the panel front shall illuminate. Where a diaphragm leak detection system is indicated on the drawings or specified to be provided for the pump, the pump shall shut down

on diaphragm leakage and an amber “Diaphragm Failure” indicating light on the panel front shall illuminate. LCD or similar type display functions are acceptable alternatives to indicating lights.

Outputs shall be provided from panels for variable speed diaphragm metering pumps as follows:

In Remote (NO dry contact)
Running (NO dry contact)
Fail (NO dry contact)
Speed (4-20 mA)
Stroke Length (4-20 mA), where electronic stroke length control is provided
Leak Detected (NO dry contact)
High Pressure (NO dry contact)

The signal controlling the Fail contact shall be generated by the SCR drive. Where high discharge pressure and/or diaphragm leakage is monitored, the Fail contact shall include these conditions. Manual reset of the failure condition shall be required at the control panel.

Where an electronic stroke length controller is specified, the controller shall be provided with a “Local-Remote” switch. When “Remote” is selected, stroke length adjustment shall be by a 4-20 mA input signal. When “Local” is selected, stroke length control by the 4-20 mA input signal shall be disabled and stroke length shall be adjusted manually. A 4-20 mA output signal proportional to stroke length shall also be provided. The controller and related devices shall have NEMA 4X enclosures.

2-8.04. Calibration Columns. Two transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	RO Feed Tank Outlet	UV/AOP System
Column ID, in	0.5	
Screwed Flow Fitting, in	0.5	
Graduated Increments, gal	0.0005	
Capacity, gal	0.02	

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-8.05. Sulfuric Acid Dilution Meter Panel. One sulfuric acid dilution panel (P-HSO4-PNL-0001) of the 2-in 2-out type shall be provided in accordance with the drawings and as specified to provide diluted sulfuric acid. The nameplates and all components shall be supplied panel-mounted by the System Integrator.

The panel shall be rigidly supported in the location indicated on the Drawings. The panel shall be constructed of stainless steel and suitably reinforced. The panel shall be a frame assembly that permits easy removal of components mounted on the panel.

All facilities shall be rigidly mounted on the panel, including piping and valves necessary for control of sulfuric acid, rotameters, and other necessary appurtenances, all as indicated and required. Piping and valves shall conform to the specification sections.

The two water rotameters shall consist of calibrated glass tubes provided with floats of materials as recommended by the manufacturer of the equipment. Each of the rotameters shall be capable of indicating flow suitable for a solution concentration of 2-10% sulfuric acid by weight. Each rotameter shall be provided with a nameplate indicating the point of application.

Two manual globe valves shall be provided on the discharge of the rotameters as indicated on the drawings. The globe valves shall meet the requirements of the Globe Valves Section.

Two motorized ball valves (90-NPW-V-001 and 90-NPW-V-0003) shall be provided for water flow to the injection quill. The globe valves shall meet the requirements of Miscellaneous Ball Valves Section.

Two motorized ball valves (90-HSO4-V-0002 and 90-HSO4-V-0004) constructed of Carpenter 20 shall be provided for sulfuric acid flow to the injection quill. The ball valves shall meet the requirements of the Miscellaneous Ball Valves Section.

Four check valves, each constructed of Carpenter 20, shall be provided on the two inlet sides of each injection quill. Each check valve shall meet the requirements of the Check Valves Section.

Two injection quills shall be provided to mix inlet water and sulfuric acid. Each injection quill shall be Neptune injection quill “Model QC-C20-50.”

Two temperature transmitters and elements (90-HS04-TE/TIT-001 and 90-HS04-TE/TIT-002 shall be furnished and installed as indicated in the Instruments Section.

Two conductivity measurement transmitters and elements (90-HS04-AE/AIT-001 and 90-HS04-AE/AIT-002 shall be furnished and installed as indicated in the Instruments Section.

Water inlet piping shall be PVC-2 as specified in the Miscellaneous Plastic Pipe Section.

Sulfuric acid inlet piping shall be CRP-1 as specified in the Miscellaneous Steel Pipe Section.

Injection quill outlet pipe shall be Teflon lined carbon steel piping as specified in the Miscellaneous Steel Pipe Section.

The panel shall have a nameplate with the words "SULFURIC DILUTION PANEL" mounted on the top of the panel.

2-8.06. Diffusers. Two diffusers shall be provided as shown on the drawings.

2-8.07. Back-Pressure valve: One properly sized back-pressure valve per pump to be shipped loose. The back pressure valve shall be constructed of material compatible with the fluid.

2-9. LIQUID AMMONIA SULFATE SYSTEM. One assembly of feeding equipment shall be furnished and installed to dispense Liquid Ammonia Sulfate to the following feed points:

- Common RO Feed

2-9.01. Tote and containment Level Measurement. Two containment pallet and scale shall be furnished and installed in the Liquid Ammonia Sulfate chemical tote storage area as shown on the drawings. This unit can be either a single assemblage as shown on the P&IDs or individual pieces. The single assemblage shall be Scaletron Industries, LTD model “4042-63 IBC” or equal. If individual pieces are used, the equipment shall be verified to fit within the space available.

2-9.01.01. Tote Containment. Each containment pallet shall have a capacity of 400 gallons and shall include a platform that can support totes measuring 38 to 50 inches in width. The maximum load capacity shall be 10,000 pounds and the pallet shall be constructed of polyethylene. Provisions shall be included to drain the pallet of rainwater.

Pallets shall be Interstate Products, Inc. “1680 IBC Spill Unit”, Scaletron Industries, Ltd. “4042-63 IBC”, or equal.

2-9.01.02. Day Tank Scale. Two electronic load cell scale of the digital type, suitable for weighing the alum day tank, shall be furnished and installed in the chemical feed area as indicated on the drawings. The scale shall have total weighing capacity of 3,000 pounds and shall be designed for floor surface mounting. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable to indicate 0 to 3,000 pounds in 1-pound increments.

The scale shall be Eagle Microsystems "LP4200 Platform Scale" with "EI 1000 Indicator", Force Flow Equipment "Model 40-DR30LP Scale" with "Wizard 4000 Indicator", Scaletron Industries, Ltd. “Model 1099”, or equal.

2-9.02. Quick Connect Coupler. Two quick connect couplers shall be furnished and installed on the hose connections for the chemical delivery tote bin as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the coupler type with cam arms and hose shank or female NPT threads for connecting to hose or piping as indicated on the drawings. The coupler shall be the same size as the hoses or piping as indicated on the drawings. The quick connect coupler shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, without exception.

2-9.03. Metering Pump Skids. One metering pump skid shall be furnished and installed as indicated on the drawings to dispense Liquid Ammonia Sulfate with a specific gravity of 1.228 to the points of application. The skid shall be located in the chemical building. The skid shall have one metering pump on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and a control panel. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams. Each skid shall have a dedicated control panel, and all power and control wiring within the skid shall be provided by the System Integrator such that the skid requires connection of a single primary 120V power circuit.

Skids shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that there is unobstructed access to the controls, pump head, and pump check valves. Valves and appurtenances shall be within easy reach from the skid edge. The skid shall have a footprint as determined by the System Integrator.

Piping on the skids shall be consistent with the Miscellaneous Plastic Piping Section. Valves shall be type VB-10 consistent with the Miscellaneous Ball Valves Section. Valves shall be labeled with valve numbers shown on the piping and instruments diagrams.

2-9.04. Metering Pumps. One metering pump shall be furnished and installed on the skid as indicated on the drawing to dispense 10.3% Liquid Ammonia Sulfate with a specific gravity of 1.228 to the feed points as listed below.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below.

Feed point	Common RO Header
Designation	90-LAS-P-0001
Installed pump quantity	One
Capacity control range, percent	0 - 100
Metering range, gph	0.02 - 0.5
Maximum speed, rpm	225
Nominal discharge pressure, psi	30

Pumps shall be positive displacement, tube-type peristaltic, case-drive pumps complete with retractable roller pump head, rotor assembly with a minimum of two compression rollers, self-contained variable speed drive, flexible extruded tube, and integral key pad control panel.

The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be constructed of material chemically resistant to the pumped solution, as acceptable to the Design-Builder. The pump shall be capable of accepting at least five tube diameters to increase capacity range. The tubing shall have a minimum wall thickness of 1.5 mm. A 50-foot section of tubing shall be provided for each pump or a total of ten spare replacement tubing assemblies shall be provided.

The pump head shall consist of a fixed track, hinged transparent guard door or removable transparent cover with lock and magnetic safety interlock and two roller rotor assemblies. The door and safety interlock shall render the drive inoperable when the door is open. Conversely, a removable cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 rpm when removed.

The tubing shall be in contact with the inside diameter of a fixed track (housing) through an angle of 180^{o} and shall be held in place on the suction and discharge

by the clamp mechanisms or pump tube assembly connection fittings. Tube clamps requiring tools will not be acceptable. Tubing replacement shall not require the use of tools.

Rotor assembly shall be equipped with a minimum of two 316 SS or polymeric compression rollers and SS bearings or two polymeric compression rollers and encapsulated SS bearings. Compression rollers shall be located a maximum of 180 degrees apart for compression of the tube against the track a minimum of twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Tube occlusion or spring tension shall be factory set for the tubing wall thickness and shall not require additional adjustment for other tubing sizes. The rotor assembly shall be securely attached to the output shaft of the drive gear motor by the manufacturer's standard assembly for that model.

The self-contained variable speed drive for each pump shall be fully operational over the entire flow range requirements indicated above. Additionally, the pumps shall be fully capable of the discharge back pressure required above. Pumps and drives shall be suitable for continuous 24-hour operation at the conditions specified.

Each pump shall be completely self-priming with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and check valves. Flow through the hose shall be in the direction of the rotor rotation and the motor shall be capable of being fully reversed.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One transparent PVC bodied Y-pattern strainer with 12-mesh screen and Viton O-ring seals.

One pressure gauge and pressure switch with isolating diaphragm in each pump discharge piping arrangement. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The isolating diaphragm shall protect the pressure gauge from the chemical solution. The pressure-switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure.

Switches shall have over-range protection to maximum process line pressure. Switches shall have weatherproof housings. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or viton and the connection port shall be stainless steel. All stem-mounted switches shall be provided with 1/2-inch NPT connections. All pressure switches shall be ranged in psi. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

One external relief valve sized to pass the maximum displacement of the pump.

One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

Leak detection system that shall detect a tubing failure by sensing the presence of liquid inside of the pump head with output signal for remote alarm.

Metering pumps shall be Watson-Marlow “Model 520 Series" or Blue & White “M-4 Series” without exception.

2-9.03.01. Metering Pump Drive Units. The pump shall be supplied with a case-drive integral reversible servo permanent magnet dc drive motor with internal gearbox to accept 120 volts ac, 60 Hz, single phase. Housing shall be pressure cast aluminum with a corrosion resistant powder coat. Unpainted housings, including 316SS, shall not be acceptable. Each pump shall not consume in excess of 790 VA. Drive unit shall be classified for continuous heavy shock duty, AGMA. Each drive unit shall be furnished with a grounded power cord and plug suitable for plugging into a standard grounded 120-volt receptacle. Power cord conductor size shall be #12 AWG minimum for both power and ground. The connection between the power cord and the drive unit shall be as recommended by the manufacturer.

The drive shall be rated Class II, 24-hour duty. Pump drive shall be closed coupled and self-aligning without requiring flexible couplings.

Drive circuitry shall be microprocessor controlled with temperature and load compensation and protection. External VFDs or SCRs shall not be acceptable.

Drive enclosure shall be NEMA 4X rated.

The drive motor shall be capable of varying the speed of the pump to deliver the metering range in gph as specified. The drive shall be provided with an “HAND-OFF-AUTO” or “REMOTE/LOCAL” control of the pump. In the “HAND” or “LOCAL” position, the pump shall run and the speed of motor shall be varied by a manual speed adjustment on the pump. In “AUTO” or “REMOTE”, the pump shall be started by a remote input dry contact. Pump speed shall be varied by a remote input 4-20 mA signal. The drive shall provide an output 4-20 mA speed signal for remote monitoring. “Running”, “In Remote” selector switch position, “High Pressure,” and “Fail” contacts shall be provided for remote monitoring. Running and fault indications shall also be provided on the pump control panel.

2-9.04. Calibration Column. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	Common RO Header
Column ID, in	0.5
Screwed Flow Fitting, in	0.5
Graduated Increments, gal	0.005
Capacity, gal	0.004

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-9.05. Diffuser. One diffuser shall be provided as shown on the drawings.

2-9.06. Back-Pressure Valve. One properly sized back-pressure valve per pump to be shipped loose. The back pressure valve shall be constructed of material compatible with the fluid.

2-10. SAFETY EQUIPMENT. Six chemical handling safety equipment kits shall be provided. Each kit shall include, but shall not be limited to, chemical splash goggles, canister type dust and mist respirator, rubber gloves, and rubber apron, all packed in a suitable carrying case.

2-11. SPARE SHELF PUMP. One shelf spare pump shall be provided for each different type of pump provided.

PART 3 - EXECUTION

3-1. SHOP INSPECTION. Should the Design-Builder elect, each pump skid shall be made available for inspection at the factory prior to being shipped. The System Integrator shall inform the Design-Builder one month prior to shipping such that arrangements can be made to inspect the equipment prior to shipping. The skids shall be set up to pump water during the inspection such that during the inspection the pump and control panel operation can be verified. Design-Builder reserves the right to reject the equipment and/or skids during the shop inspection including but not limited to incorrect pipe materials, incorrect valve types, incorrect solvent cements, shoddy construction, and equipment malfunction.

3-2 SHIPPING. Prior to being shipped, the skids shall be thoroughly dried. Shipping of the skids shall conform to the Shipping section such that the skids are not damaged in transit.

3-3. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with Drawings, specifications, and recommendations of the equipment manufacturer, unless exceptions are noted by the Design-Builder. All items necessary for a complete operating system shall be installed.

3-3.01. Equipment Bases. Unless otherwise specified or indicated on the Drawings, each item of chemical feed equipment shall be mounted on a concrete base approximately six inches above the floor. If feeders or other components must be supported at higher elevations above the floor, suitable supplementary bases shall be provided.

3-3.02. Installation Check. An experienced, competent, and authorized representative of the System Integrator shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when equipment is placed in operation and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The System Integrator's representative shall furnish a written report certifying that the equipment has been properly installed; that gas piping has been properly cleaned; is in accurate alignment; is free from undue stress imposed by connecting piping or anchor bolts; and has been operated at full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price for the number of days and round trips to the site as required.

3-4. CLEANING. At the completion of installation and testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired.

3-5. TRAINING. The System Integrator shall provide a qualified representative at the jobsite for one day to train the Owner's personnel in operating and maintaining the equipment.

End of Section

Section 43 40 41

POLYMER FEED SYSTEMS

PART 1 - GENERAL

1-1. SCOPE. This section covers polymer feed equipment and accessories. Principal items to be furnished and installed shall include the following:

Polymer Feed System.

One tote mixer
One containment with integral scale.
One quick connect coupler.
One polymer feeder/blender system skid.
One shelf spare neat polymer pump
One calibration column.

The following items of work and equipment are covered under other sections:

Piping and valves between items of equipment.
Water supply and electric power supply to the equipment.
Drain and vent piping.

1-2. SYSTEM INTEGRATOR. The polymer feed systems shall be designed, coordinated, and supplied by a competent System Integrator. The System Integrator shall be regularly engaged in the business of designing and assembling polymer feed systems for water treatment or wastewater treatment plant projects. The System Integrator shall be responsible for ensuring that a complete functioning system is supplied for each Polymer Feed System. The System Integrator shall be responsible for coordinating all equipment, piping, and valves, and appurtenances for each Polymer Feed System as well as coordination with the Dewatering System Supplier where the polymer will be used. In lieu of a separate package, the Dewatering System Supplier may provide the polymer feed system if it meets all requirements specified herein.

1-2.01 System Integrator Qualifications. The System Integrator shall meet all of the following requirements and within 30 days after the Notice of Award, shall submit proof of the following qualifications for the intended System Integrator:

The System Integrator has successfully provided similar work for at least 5 years.

The names of at least three references who are users of similar systems designed, assembled, and furnished by the System Integrator.

The System Integrator has the required financial capability.
The names of manufacturers whose products will be supplied.

The System Integrator maintains a qualified technical staff and design office.

The System Integrator has the physical plant and fabricating personnel to complete the work specified.

The System Integrator has and will maintain competent service personnel to service the equipment furnished.

1-3. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Design-Builder.

Each item shall be furnished and installed complete with all mechanical and electrical equipment required for proper operation, all components indicated on the drawings or specified, and all additional materials or construction required by the design of the system.

1-3.01. Coordination. The System Integrator shall verify that each system component is compatible and consistent with all other components of the system, that all pipe materials and sizes are appropriate, and that all devices necessary for a properly functioning system have been provided. Devices and appurtenances necessary for a properly functioning system shall be constructed of materials consistent with the piping materials unless otherwise indicated. The System Integrator shall assume responsibility for ensuring that Minimum Suction Head and NPSH available is adequate for the supplied pumps.

Similar components of different polymer feed systems shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

Review of drawings submitted prior to the final determination and coordination of related equipment to be provided will not relieve the System Integrator from responsibility for supplying systems in full compliance with the specific requirements of the related equipment.

1-3.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. Piping on skids shall be constructed consistent with the piping and valve specifications.

1-3.03. Governing Standards. All electrical equipment shall conform to applicable standards of the National Electrical Manufacturers Association and the National Electrical Code.

1-3.04. Power Supply. Unless otherwise specified, the power supply will be 120 volts, 60 Hz, single phase. Where control voltage lower than the power supply voltage is required, a suitable control power transformer shall be furnished. Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

1-3.05. Metal Thicknesses. Metal thicknesses and gauges specified herein are the minimum required. Gauges refer to US Standard gauge.

1-3.06. Nameplates. A nameplate shall be provided and mounted on or adjacent to each piece of polymer feed equipment to identify its function. Nameplates shall be approximately 1 by 3 inches, made from black on white phenolic material. Letters shall be engraved to the white interior and shall be at least 3/16-inch high. Feeder designations on the nameplates shall correspond to those indicated on the drawings.

1-3.07. Spare Parts. A list of recommended spare parts with pricing shall be furnished during the submittal phase.

1-4. SUBMITTALS. Submittals for polymer feed systems shall have the following organization and information as a minimum.

1-4.01. Submittal Organization. The submittal shall be split up into different sections with a separate section for each polymer feed system. Each system section shall be supplied with the following information.

System Integrator Name, Contact Name, Phone Number, Address, and email address.

System Integrator Contact Name Qualifications and Experience.

Bill of Materials.

System piping and instrumentation diagram with legend.

Equipment and piping layout starting from dry polymer hopper/bulk storage tank pump suction nozzle to discharge piping of metering pumps.

Liquid polymer feeder/blender selection.

Dilution water appurtenances.

Polymer system control panel layout and wiring diagram.

Control narrative.

Spare parts.

1-4.02. Drawings and Data. Complete fabrication, assembly, installation and equipment and piping layout drawings, piping and instrumentation diagrams, and wiring diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Section. A narrative description of the proposed control method, including all automatic operations, electrical interlocks, alarms, and interfaces to the Plant Control System shall be submitted.

1-4.03. Calibration Graphs. The System Integrator shall prepare a calibration graph from field tests for each polymer feed unit which does not have a rate set device reading in pounds per hour for dry feeders or in gallons per hour for liquid feeders. The graph shall show the rate setter graduation conversion to pounds per hour or gallons per hour throughout the range of the feed unit. Each graph shall be furnished on hard paper and sealed in clear plastic.

1-4.05. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied and shall be submitted in accordance with the submittals section. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

a. Equipment function, normal operating characteristics, and limiting conditions.
b. Assembly, installation, alignment, adjustment, and checking instructions.
c. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.
d. Lubrication and maintenance instructions.
e. Guide to troubleshooting.
f. Parts lists and predicted life of parts subject to wear.
g. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.
h. Test data and performance curves, where applicable.
i. A listing of all filter locations, type, size, and quantity associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2-1. SYSTEM INTEGRATOR. The polymer feed system shall be coordinated and supplied by a qualified System Integrator who is regularly engaged in the business of designing and assembling polymer feed systems for water treatment or wastewater treatment plant projects.

2-2. CONSTRUCTION. Polymer feed equipment shall be of substantial construction with all parts designed for long life under working conditions including corrosive atmospheres and intermittent or continuous operation. All wearing parts and items requiring adjustment shall be readily accessible. Each unit shall be completely enclosed and dusttight when in operation. All parts which are exposed to corrosive conditions shall be made from corrosion-resistant materials or covered with suitable protective coatings.

2-3. THICKENING POLYMER FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed, with the coordination of the Dewatering System Supplier, to dispense thickening polymer solution to the following feed points:

- Belt Filter Press No. 1

2-3.01. Tote Mixer. One electric motor driven mixer shall be provided to mix the contents of the totes of polymer. The mixer shaft and paddles shall be constructed of Type 316 stainless steel and shall pass through the 2-inch opening of a tote. The mixer base shall be supported by a clamp and adjustable mounting bracket. The adjustable mounting bracket shall be adjustable from 32 inches to 50 ½ inches wide and be made of steel. The mixer shall be capable of mixing 1,500 cps viscosity polymer at less than 500 revolutions per minute.

The mixer shall be provided complete with tote adjustable mounting brackets, plastic drip pans, and grounding cords and plug assemblies.

The mixer shall be provided with a manual starter with automatically reset thermal overload protection, housed in a NEMA Type 4X enclosure.

The mixer shall be Neptune “DT Series” or equal

2-3.02. Tote and containment Level Measurement. One containment pallet and scale shall be furnished and installed in the thickening polymer chemical tote storage area as shown on the drawings. This unit can be either a single assemblage as shown on the P&IDs or individual pieces.

2-3.02.01. Tote Containment. The containment pallet shall have a capacity of 400 gallons and shall include a platform that can support totes measuring 38 to 50 inches in width. The maximum load capacity shall be 10,000 pounds and the pallet shall be constructed of polyethylene. Provisions shall be included to drain the pallet of rainwater.

Pallets shall be Interstate Products, Inc. “1680 IBC Spill Unit”, Scaletron Industries, Ltd. “4042-63 IBC”, or equal.

2-3.02.02. Day Tank Scale. One electronic load cell scale of the digital type, suitable for weighing the neat thickening polymer tote, shall be furnished and installed in the chemical feed area as indicated on the drawings. The scale shall have total weighing capacity of 3,000 pounds and shall be designed for floor surface mounting. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable to indicate 0 to 3,000 pounds in 1-pound increments.

The scale shall be Eagle Microsystems "LP4200 Platform Scale" with "EI 1000 Indicator", Force Flow Equipment "Model 40-DR30LP Scale" with "Wizard 4000 Indicator", Scaletron Industries, Ltd. “Model 1099”, or equal.

2-3.03. Quick Connect Coupler. One quick connect coupler shall be furnished and installed on the hose connections for the chemical delivery tote bin as indicated on the drawings. The material of construction shall be compatible with the chemical and approved by the Design-Builder. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D. The quick connect fitting shall be the coupler type with cam arms and hose shank or female NPT threads for connecting to hose or piping as indicated on the drawings. The coupler shall be the same size as the hoses or piping as indicated on the drawings. The quick connect coupler shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, without exception.

2-3.04. Dilution Water Accessories. The following accessories shall be furnished and installed on the water pipe upstream of the polymer feeder/blender.

One back pressure valve shall be provided. The back pressure valve shall meet the requirements of the Back Pressure Valve section.

One pressure gauge with indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window shall be provided. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be

selected so that gauge readings will be mid-scale under normal operating conditions.

2-3.05. Liquid Polymer Feed System. The liquid polymer system shall pull neat, liquid polymer from a storage tote, blend it into a solution with water from the plant water supply, and transfer the solution to the Belt Filter Press No. 1.

The liquid polymer feed system shall be Fluid Dynamics “Dynablend L Series”, US Filter/Stranco "Polyblend M-Series", or Velodyne “VeloBlend Series,” without exception. Manufacturer’s standard equipment shall be modified as required to comply with the specification requirements.

2-3.05.01. Polymer Feeder/Blender. One polymer feeder/blender unit shall be furnished and installed. Each unit shall include a neat polymer pump, blender and controller, and shall be capable of automatically metering, diluting, activating and transferring liquid solution polymer with water. Each blending unit shall be capable of effectively activating a wide range of polymers.

Each unit shall be sized for a capacity of 0.6 gallons per hour of liquid polymer and be capable of delivering a 1% solution by weight to the feed point. Each polymer feeder/blender shall transfer the blended polymer solution to the feed point as indicated on the drawings.

All metal components in contact with the polymer or polymer solutions shall be Type 304 or 316 stainless steel. All piping material shall be Schedule 80 PVC. Valves shall be constructed of stainless steel or PVC and shall use chemically resistant seats and seals. All components that require periodic maintenance shall be readily accessible. The skid shall be constructed of stainless steel. The skid shall have forklifting points for ease of transportation.

2-3.05.02. Dilution Water Control. Primary dilution water shall be supplied to each mixing chamber of the polymer feeder/blenders at a target rate of 1.0 gallon per minute with capacity for up to 2.0 gallons per minute. Each blender/feeder unit shall have a manual rate set valve for throttling of water flow and an electrically operated valve for on/off control of dilution water.

Water control components and piping shall include pressure switches, pressure gauges, and rotameters to control water capacity as required through the feeder/blender. The pressure switches shall not allow the system to operate with inadequate water supply pressure. The feeder/blender unit shall have a rotameter to measure primary dilution water flow into the feeder/blender. Each rotameter shall consist of an acrylic tube provided with a float constructed of material as recommended by the rotameter manufacturer. Each rotameter shall be capable of indicating a maximum flow as determined by the System Integrator for the dilution rate required.

Stainless steel, liquid filled dilution water pressure gauges shall be provided integral to each feeder/blender to measure both dilution water inlet pressure and mixing chamber pressure.

2-3.05.03. Neat Polymer Transfer Pump. One neat polymer transfer pump shall be furnished and installed as indicated on the drawings to dispense neat polymer to the feeder/blender system.
One additional neat polymer transfer pump shall be furnished to be a shelf spare.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements listed in the table below in coordination with the Dewatering System Supplier. If requirements for the Dewatering System vary from what is shown herein, Design-Builder shall be notified.

Feed point	Belt Filter Press No. 1
Designation	MSH-0001
Installed pump quantity	One
Shelf spare pump quantity	One
Capacity control range, percent	0 - 100
Metering range, gph	0.22 – 0.60 (or as recommend by Belt Filter Press Supplier)
Maximum speed, rpm	225
Nominal discharge pressure, psi	30

Pumps shall be positive displacement, tube-type peristaltic, case-drive pumps complete with retractable roller pump head, rotor assembly with a minimum of two compression rollers, self-contained variable speed drive, flexible extruded tube, and integral key pad control panel.

The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be constructed of material chemically resistant to the pumped solution, as acceptable to the Design-Builder. The pump shall be capable of accepting at least five tube diameters to increase capacity range. The tubing shall have a minimum wall thickness of 1.5 mm. A 50-foot section of tubing shall be provided for each pump or a total of ten spare replacement tubing assemblies shall be provided.

The pump head shall consist of a fixed track, hinged transparent guard door or removable transparent cover with lock and magnetic safety interlock and two roller rotor assemblies. The door and safety interlock shall render the drive inoperable when the door is open. Conversely, a removable cover shall include

an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 rpm when removed.

The tubing shall be in contact with the inside diameter of a fixed track (housing) through an angle of 180^{o} and shall be held in place on the suction and discharge by the clamp mechanisms or pump tube assembly connection fittings. Tube clamps requiring tools will not be acceptable. Tubing replacement shall not require the use of tools.

Rotor assembly shall be equipped with a minimum of two 316 SS or polymeric compression rollers and SS bearings or two polymeric compression rollers and encapsulated SS bearings. Compression rollers shall be located a maximum of 180 degrees apart for compression of the tube against the track a minimum of twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Tube occlusion or spring tension shall be factory set for the tubing wall thickness and shall not require additional adjustment for other tubing sizes. The rotor assembly shall be securely attached to the output shaft of the drive gear motor by the manufacturer's standard assembly for that model.

The self-contained variable speed drive for each pump shall be fully operational over the entire flow range requirements indicated above. Additionally, the pumps shall be fully capable of the discharge back pressure required above. Pumps and drives shall be suitable for continuous 24-hour operation at the conditions specified.

Each pump shall be completely self-priming with a suction lift capability of up to 30 feet of water. The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and check valves. Flow through the hose shall be in the direction of the rotor rotation and the motor shall be capable of being fully reversed.

Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

One pressure gauge with isolating diaphragm in each pump discharge piping arrangement. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions. The isolating diaphragm shall protect the pressure gauge from the chemical solution.

One external relief valve sized to pass the maximum displacement of the pump.

Leak detection system that shall detect a tubing failure by sensing the presence of liquid inside of the pump head with output signal for remote alarm.

Metering pumps shall be Watson-Marlow “Model 520 Series" or Blue & White “M-4 Series” without exception.

2-3.05.04. Metering Pump Drive Units. The pump shall be supplied with a case-drive integral reversible servo permanent magnet dc drive motor with internal gearbox to accept 120 volts ac, 60 Hz, single phase. Housing shall be pressure cast aluminum with a corrosion resistant powder coat. Unpainted housings, including 316SS, shall not be acceptable. Each pump shall not consume in excess of 790 VA. Drive unit shall be classified for continuous heavy shock duty, AGMA. Each drive unit shall be furnished with a grounded power cord and plug suitable for plugging into a standard grounded 120-volt receptacle. Power cord conductor size shall be #12 AWG minimum for both power and ground. The connection between the power cord and the drive unit shall be as recommended by the manufacturer.

The drive shall be rated Class II, 24-hour duty. Pump drive shall be closed coupled and self-aligning without requiring flexible couplings.

Drive circuitry shall be microprocessor controlled with temperature and load compensation and protection. External VFDs or SCRs shall not be acceptable.

Drive enclosure shall be NEMA 4X rated.

The drive motor shall be capable of varying the speed of the pump to deliver the metering range in gph as specified. The drive shall be provided with an “HAND-OFF-AUTO” or “REMOTE/LOCAL” control of the pump. In the “HAND” or “LOCAL” position, the pump shall operate and the speed of motor shall be varied by a manual speed adjustment on the pump. In “AUTO” or “REMOTE”, the pump shall be started by a remote input dry contact. Pump speed shall be varied by a remote input 4-20 mA signal. The drive shall provide an output 4-20 mA speed signal for remote monitoring. “Running”, “In Remote” selector switch position, and “Fail” contacts shall be provided for remote monitoring. Running and fault indications shall also be provided on the pump control panel.

2-3.05.05. Activation Chamber. Polymer activation shall be accomplished using one of two options: a hydrodynamic blending device or a motor driven activation device.

The hydrodynamic blending device shall be cylindrical, non-mechanical, and shall be specifically designed to dilute and activate polymer. The activation chamber's mixing energy shall be staged such that it provides for high, non-damaging mixing energy over the full operating range of the system. At no time shall polymer be exposed to excessive shear. A mixing chamber drain valve with a ½-inch fitting shall be provided.

The motor driven activation device shall be a horizontally mounted activation chamber consisting of a rotor and stationary sleeve, each constructed of polymer-resistant synthetic materials. When rotating, the rotor shall generate a turbulent blending action within a number of horizontal cylindrical chambers internal to the rotor. Activated polymer solution shall exit from within these chambers through a series of radial openings and pass through a controlled shear zone at the interface of the rotor into the stationary sleeve. Activated solution shall then flow through a series of slots in the sleeve and out of the activation chamber. A minimum 1.5 hp washdown duty motor, shall drive the mixer impeller. Impeller speed shall be not exceed 3,450 rpm. The motor shall be direct-coupled to the impeller shaft. Each motor shall comply with the Common Motor Requirements of Process Equipment Section except as specified herein. Each motor shall be horizontal, squirrel-cage induction type rated 460 volts, three phase, 60 Hz with a totally enclosed fan cooled (TEFC) or totally enclosed non-ventilated (TENV) enclosure.

2-3.06. Calibration Column. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be clear PVC or other resistant, rigid, transparent plastic tubing having a vented top cap and screwed flow fitting. Each column shall be graduated in the respective increments over the specified range, complete with a numeral at each graduation.

Feed point	Belt Filter Press No. 1
Column ID, in	0.5
Screwed Flow Fitting, in	0.5
Graduated Increments, gal	0.0005
Flow range, gal	0.01

The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2-3.07. Diffusers. One diffuser shall be provided as shown on the drawings.

2-4. SAFETY EQUIPMENT. One chemical handling safety equipment kit shall be provided. Each kit shall include, but shall not be limited to, chemical splash goggles, canister type dust and mist respirator, rubber gloves, and rubber apron, all packed in a suitable carrying case.

PART 3 - EXECUTION

3-1. INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with Drawings, specifications, and recommendations of the equipment manufacturer, unless exceptions are noted by the Design-Builder. All items necessary for a complete operating system shall be installed.

3-1.01. Equipment Bases. Unless otherwise specified or indicated on the Drawings, each item of chemical feed equipment shall be mounted on a concrete base approximately six inches above the floor. If feeders or other components must be supported at higher elevations above the floor, suitable supplementary bases shall be provided.

3-2. CLEANING. At the completion of installation and testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired .

3-3. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer’s expense.

3-4. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-4.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-4.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 43 41 45.13

FIBERGLASS REINFORCED PLASTIC TANKS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of tanks fabricated of fiberglass reinforced plastic and intended for aboveground bulk storage of chemical solutions and process fluids as indicated herein.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Design-Builder.

1-2.01. Coordination. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.04. Governing Standards. Except as modified or supplemented herein, materials and construction methods shall conform with the applicable provisions of the following standards:

> Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment, ASTM C582.
>
> Standard Specification for Filament-Wound Glass-Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks, ASTM D3299.
>
> Standard Specification for Contact-Molded Glass-Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks, ASTM D4097.

1-2.05. Nameplates. Each tank shall be provided with a nameplate. The nameplates shall be of white phenolic material with black engraved lettering 3 inches high, and shall be mounted on the tank straight shell. The chemical name and the tank tag number indicated on the Tank Data Sheet shall be engraved on the nameplate.

1-2.06. Certification Plates. A stainless steel certification plate shall be mounted a maximum of four feet above the tank bottom on the side of each storage tank. Bracketed flat surfaces shall be provided on the tank for installation of nameplate and certification plate.

At least the following data shall be included on the certification plate:

Name of tank fabricator.

Date of manufacture.

Manufacturer's serial number.

Resin designation for entire tank (structural and corrosion barrier).

Maximum allowable concentration and temperature of the specified chemical solution that can be stored safely.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete drawings, details, and specifications covering the storage tanks, connections, and accessories shall be submitted in accordance with the Submittals Procedures section.

The data shall include full information on all tank fabrication materials and test data confirming the chemical resistance of the proposed resins to the intended tank contents.

Drawings shall include a profile diagram of the entire tank wall resin system indicating the thickness, resin designation, reinforcement, and surfacing matt material of each layer including the structural and corrosion barrier layers.

The data shall also indicate the sizes of all major tank components; size, spacing, and design loading of supporting saddles; anchor bolt locations and details; and full information and details concerning field assembly and installation.

A total of three cutouts from each tank shall be provided and shipped with and attached to the associated tank. The cutouts shall consist of one from the roof and two from the tank wall. The cutouts shall be from any of the tank connections with a diameter of 2 inches or larger.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the general Terms and Conditions and the manufacturer's recommendations. Handling and storage shall be in accordance with the manufacturer recommendations and this Section.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. Each tank shall be designed for storage of the fluid or chemical at the design conditions specified in the attached Tank Data Sheet(s).

Useable capacity shall be measured from the invert of the tank overflow nozzle to the top of the pump suction nozzle.

Vertical tanks shall be vertical cylinders with a bottom and top constructed as specified herein. Horizontal tanks shall be a horizontal cylinder with flat or dished heads and supported on saddles. Tanks shall be provided with a suitable overflow connection. Tanks shall be vented and will normally be used to store the specified chemical at atmospheric pressure, but shall be designed to withstand the hydrostatic head resulting from the tank being surcharged to 6 inches above the top of the tank.

Design criteria for calculating wind, snow and seismic loads shall be as indicated in the Meteorological and Seismic Design Criteria section.

2-1.01. Tank Bases. Unless otherwise indicated or specified, all tanks shall be installed on concrete bases at least 6 inches high. The tanks shall be anchored to the concrete base with suitable anchor bolts.

2-2. RECOMMENDED MANUFACTURERS. Recommended manufacturers shall be as specified in the Tank Data Sheet.

2-3. MATERIALS.

Resin	Bisphenol-A polyester or vinyl ester resins suitable for use with the specified chemical as recommended by the resin manufacturer.
Reinforcement	Boron free E-CR glass for mat, woven roving and roving for filament winding.
Surfacing Mat	Nexus veil by Precision Fabrics Group.
Plastic Laminate	In conformity with the applicable governing standards.

Also reference the attached Tank Data Sheet(s) for additional materials requirements.

2-4. CONSTRUCTION. The tanks shall be of hand lay-up, spray-up, or filament-wound construction in accordance with the applicable governing standard. The entire tank, structural and corrosion barrier, shall be constructed of a single generic type of thermoset resin and shall not contain colorants, dyes, fillers, or pigments unless otherwise specified. Ultraviolet absorber shall be added to the resin used in the fabrication of tanks indicated in the Tank Data Sheet(s) for installation in outdoor locations.

The inner surface layer of sodium hypochlorite and the hydrofluosilicic acid tanks shall consist of a resin rich corrosion barrier with a minimum thickness of 120 mils. The surface of the corrosion barrier exposed directly to the corrosive chemical shall consist of a two-ply surfacing veil with a minimum thickness of 20 mils. The remainder of the corrosion barrier shall consist of two layers or more of chopped strand mat or equivalent.

The inner surface layer of hydrochloric acid tanks shall consist of a resin rich corrosion barrier with a minimum thickness of 200 mils. The surface of the corrosion barrier exposed directly to the corrosive chemical shall consist of a two-ply surfacing veil with a minimum thickness of 20 mils. The remainder of the corrosion barrier shall consist of two layers or more of chopped strand mat or equivalent.

The inner surface layer of all other tanks shall consist of a resin rich corrosion barrier with a minimum thickness of 110 mils. The surface of the corrosion barrier exposed directly to the corrosive chemical shall consist of a singly-ply surfacing veil with a minimum thickness of 10 mils. The remainder of the corrosion barrier shall consist of two layers or more of chopped strand mat or equivalent.

Sodium hypochlorite tanks shall be catalyzed with a benzoyl peroxide/dimethyl aniline (BPO/DMA) catalyst system. Each tank shall undergo a four hour dry oven post-cure at a minimum temperature of 180°F after fabrication per the resin manufacturer's recommendation. Use of thixotropic resin additives will not be allowed. Alternative catalyst systems will be considered if written confirmation from the resin manufacturer verifying the effectiveness of the proposed system is provided.

When a vertical tank with removable top is required, the tank shall be provided with an outward projecting stiffening flange for connection of the removable top. A chemical resistant elastomeric gasket and assembly bolts shall be furnished for attachment of the top.

When a vertical tank with a flat or closed top is required, the top of the tank shall be reinforced as specified in the applicable governing standard. Additional reinforcement shall be provided as necessary to support the required accessories and personnel loads. Tank roofs shall be provided with nonskid strips or a nonslip finish over the entire roof surface.

The tank shall be provided with the appropriate number and size of lifting lugs for handling and installation and hold-down lugs for anchoring the tank to the concrete base.

2-5. ACCESSORIES.

2-5.01. Special Tools and Accessories. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2-5.02. Access Manways. Access manways shall have a nominal diameter of 24 inches. The number and location of access manways on the tank shall be as indicated in the Tank Nozzle Schedule. Each manway shall be flanged, fully gasketed, and furnished with a fabricated blind flange having the same properties as the tank wall laminate. Flange diameter and drilling shall conform to (ANSI B16.5, Class 150) ASTM D3299 Table 5. Side access manways shall be centered approximately 3 feet above the bottom of the tank.

2-5.03. Hinged Covers. Not used.

2-5.04. Flanged Nozzles. Nozzles for connecting piping and accessories shall be provided on each tank at the locations and of the sizes as indicated in the Tank Data Sheet.

Each nozzle shall be flanged, with flange diameter and drilling conforming to ANSI B16.5, Class 150. Nozzles shall extend at least 4 inches from outside face of tank to face of flange.

Flanged nozzles shall be fabricated of the same material as the tank and shall be gusseted to the tank or otherwise reinforced in accordance with the governing standard.

The mounting flange for ultrasonic type transmitters shall be not less than 18 inches above the maximum liquid level. The center line of the nozzle shall be at least 24 inches from the tank sidewall, fill nozzle, and other obstructions.

2-5.05. Vents. The tank shall be provided with a vent of the size recommended by the manufacturer, but not less that the size indicated on the Tank Nozzle Schedule, to prevent pressurizing the tank during filling or drawing a vacuum inside the tank during pumping or draining. The vent shall be as specified in the Tank Data Sheet.

2-5.06. Tank Insulation. Not used.

2-5.07. Tank Heater. Not used.

2-5.08. Ladders and Handrail. Not used.

2-5.09. Sight Level Gauge. Each tank shall be provided with a sight level gauge when required per drawings. The gauges shall be clear type or magnetic flag type, as specified in the Tank Data Sheet.

2-5.09.01. Clear Type Level Gauge. When specified in the Tank Data Sheet, a chemical-resistant valve and gauge tube assembly shall be mounted on the tank. The exterior tube of the gauge tube shall be fabricated of 1 inch diameter clear PVC, polycarbonate, or borosilicate glass. The interior wetted tube shall be clear PFA Teflon or other material, as specified. An epoxy coated steel or fiberglass shield which does not obstruct the gauge shall be provided the full length of the gauge. Alternatively, the gauge tube shall be fabricated of 1 inch diameter FEP (Fluorinated Ethylene Propylene) with flair through flange end connections. The FEP gauge tube shall have a wall thickness of 0.1 inch and the flanges shall be epoxy-coated ductile iron. A graduation strip shall be mounted adjacent to or integral with the sight level gauge. The strip shall run the full length of the level gauge and shall be graduated in gallons using 1 inch high black lettering over a range from zero gallons to the rated capacity of the tank. The gauge tube assembly shall be Jogler Inc. Model ULSS, Pureflex Inc. Model Puresite, or equal.

2-5.09.02. Magnetic Flag Type Gauges. Not used.

2-5.10. Saddles. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Equipment furnished under this section shall be installed in accordance with the Chemical Storage Tank Installation section.

End of Section

Section 43 41 45.13-DS01

FIBERGLASS REINFORCED PLASTIC TANKS

Tank Data Sheet – Sodium Hypochlorite Storage Tank		
General		
	Fluid service.	Sodium Hypochlorite
	P&ID drawing reference.	90-I-001
	Tank tag number(s).	NOCL-T-0001
	Number of tanks.	1
Design Requirements		
	Chemical concentration, percent by weight.	12.5%
	Maximum specific gravity.	1.18
	Maximum ambient temperature.	110° F
	Installed location.	Outdoor (under canopy)
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Domed
	Usable capacity.	5,870 Gal
	Tank diameter.	10 ft
	Straight shell length/height.	Determined by mfg
	Maximum total length/height.	Determined by mfg
	Recommended manufacturers.	Belding, Beetle, Tankinetics, Plasticon, Augusta, or equal
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	Yes
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	ASTM A36 Carbon Steel with fiberglass reinforced coating
	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Gaskets.	Viton (FKP)

Accessories				
	Tank vent.			Gooseneck type
	Ladder required.			No
	Handrail required.			No
	Sight level gauge.			Clear type
	Material for clear type, exterior tube.			Clear PVC
	Material for clear type, interior wetted tube.			PFA
	Material for Magnetic flag type.			N/A
	Drawings for nozzle orientation.			Refer to Civil / Mechanical Drawings
Tank Nozzle Schedule				
	Quantity	Connection	Location	Size (in)
	1	Tank fill.	Top	2
	1	Pump suction.	Side bottom	2
	1	Drain.	Side bottom	2
	2	Level gauge.	Side top and bottom	2
	1	Overflow.	Side top	3
	1	Vent.	Top	4
	2	Manway.	Top, side bottom	24
	1	Level sensor.	Side bottom	3

FIBERGLASS REINFORCED PLASTIC TANKS

Tank Data Sheet – Sodium Hydroxide Storage Tank		
General		
	Fluid service.	Sodium Hydroxide
	P&ID drawing reference.	90-I-003
	Tank tag number(s).	NAOH-T-0001
	Number of tanks.	1
Design Requirements		
	Chemical concentration, percent by weight.	25%
	Maximum specific gravity.	1.28
	Maximum ambient temperature.	110° F
	Installed location.	Outdoor (under canopy)
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Domed
	Usable capacity.	5,870 Gal
	Tank diameter.	10 ft
	Straight shell length/height.	Determined by mfg
	Maximum total length/height.	Determined by mfg
	Recommended manufacturers.	Belding, Beetle, Tankinetics, Plasticon, Augusta, or equal
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	Yes
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	ASTM A36 Carbon Steel with fiberglass reinforced coating
	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Gaskets.	Viton (FKP)

Accessories				
	Tank vent.			Gooseneck type
	Ladder required.			Yes
	Handrail required.			No
	Sight level gauge.			Clear type
	Material for clear type, exterior tube.			Clear PVC
	Material for clear type, interior wetted tube.			PFA
	Material for Magnetic flag type.			N/A
	Drawings for nozzle orientation.			Refer to Civil / Mechanical Drawings
Tank Nozzle Schedule				
	Quantity	Connection	Location	Size (in)
	1	Tank fill.	Top	2
	1	Pump suction.	Side bottom	2
	1	Drain.	Side bottom	2
	2	Level gauge.	Side top and bottom	2
	1	Overflow.	Side top	3
	1	Vent.	Top	4
	2	Manway.	Top, side bottom	24
	1	Level sensor.	Side bottom	3

FIBERGLASS REINFORCED PLASTIC TANKS

Tank Data Sheet – Outfall Balancing Tank		
General		
	Fluid service.	Treated WW Effluent
	P&ID drawing reference.	64-I-001
	Tank tag number(s).	TW-T-0001
	Number of tanks.	1
Design Requirements		
	Chemical concentration, percent by weight.	N/A
	Maximum specific gravity.	1.06
	Maximum ambient temperature.	110° F
	Installed location.	Outdoor
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Domed
	Usable capacity.	18182 Gal
	Tank diameter.	12 ft
	Straight shell length/height.	21.5 ft
	Maximum total length/height.	22.5 ft
	Recommended manufacturers.	Belding, Beetle, Tankinetics, Plasticon, Augusta, or equal
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	No
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	N/A
	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Gaskets.	EPDM
Accessories		
	Tank vent.	Gooseneck type
	Ladder required.	No

	Handrail required.	No
	Sight level gauge.	N/A
	Material for clear type, exterior tube.	Clear PVC
	Material for clear type, interior wetted tube.	Clear PVC
	Material for Magnetic flag type.	N/A
	Drawings for nozzle orientation.	Refer to Civil / Mechanical Drawings

Tank Nozzle Schedule

	Quantity	Connection	Location	Size (in)
	1	Tank fill from RO permeate.	Top	8
	1	Tank fill from RO bypass.	Top	8
	1	Tank fill from off spec UV.	Top	8
	1	Tank fill from RO feed tank.	Top	12
	1	Tank fill from SAFE Filter.	Side bottom	20
	1	Pump suction.	Side bottom	20
	1	Drain.	Side bottom	3
	1	Overflow.	Side top	20
	1	Vent.	Top	10
	1	Manway.	Side bottom	24
	1	Level sensor.	Side bottom	3
	2	Level switch.	Side top and bottom	2

FIBERGLASS REINFORCED PLASTIC TANKS

Tank Data Sheet – RO Feed Tanks		
General		
	Fluid service.	MBR Effluent
	P&ID drawing reference.	33-I-001
	Tank tag number(s).	RO-T-0101, RO-T-0201
	Number of tanks.	2
Design Requirements		
	Chemical concentration, percent by weight.	N/A
	Maximum specific gravity.	1.06
	Maximum ambient temperature.	110° F
	Installed location.	Outdoor
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Domed
	Usable capacity (per tank).	15,000 Gal
	Tank diameter.	12 ft
	Straight shell length/height.	24.5 ft
	Maximum total length/height.	26.5 ft
	Recommended manufacturers.	Belding, Beetle, Tankinetics, Plasticon, Augusta, or equal
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	No
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	N/A
	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Gaskets.	EPDM
Accessories		
	Tank vent.	Gooseneck type
	Ladder required.	No

	Handrail required.	No
	Sight level gauge.	N/A
	Material for clear type, exterior tube.	N/A
	Material for clear type, interior wetted tube.	N/A
	Material for Magnetic flag type.	N/A
	Drawings for nozzle orientation.	Refer to Civil / Mechanical Drawings

Tank Nozzle Schedule

	Quantity	Connection	Location	Size (in)
	1	Tank fill from MBR filtrate.	Side bottom	12
	1	Pump suction.	Side bottom	12
	1	Drain.	Side bottom	3
	1	Overflow.	Side top	12
	1	Vent.	Top	10
	1	Manway.	Side bottom	24
	1	Level sensor.	Side bottom	3
	2	Level switch.	Side top and bottom	2

FIBERGLASS REINFORCED PLASTIC TANKS

Tank Data Sheet – Calcite System BW Waste Holding Tank		
General		
	Fluid service.	Calcite fines backwash
	P&ID drawing reference.	61-I-001
	Tank tag number(s).	CAL-T-0001
	Number of tanks.	1
Design Requirements		
	Chemical concentration, percent by weight.	N/A
	Maximum specific gravity.	1.06
	Maximum ambient temperature.	110° F
	Installed location.	Outdoor
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Domed
	Usable capacity (per tank).	34,000 Gal
	Tank diameter.	16 ft
	Straight shell length/height.	24.5 ft
	Maximum total length/height.	26.5 ft
	Recommended manufacturers.	Belding, Beetle, Tankinetics, Plasticon, Augusta, or equal
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	No
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	N/A
	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Gaskets.	EPDM
Accessories		
	Tank vent.	Gooseneck type
	Ladder required.	No

	Handrail required.	No
	Sight level gauge.	No
	Material for clear type, exterior tube.	N/A
	Material for clear type, interior wetted tube.	N/A
	Material for Magnetic flag type.	N/A
	Drawings for nozzle orientation.	Refer to Civil / Mechanical Drawings

Tank Nozzle Schedule

	Quantity	Connection	Location	Size (in)
	1	Tank fill from calcite system.	Top	10
	1	Drain.	Side bottom	3
	1	Overflow.	Side top	12
	1	Vent.	Top	10
	1	Manway.	Side bottom	24
	1	Level sensor.	Side bottom	3

FIBERGLASS REINFORCED PLASTIC TANKS

Tank Data Sheet – Scum/WAS Wetwell		
General		
	Fluid service.	Scum/WAS from MBR
	P&ID drawing reference.	31-I-003
	Tank tag number(s).	
	Number of tanks.	1
Design Requirements		
	Chemical concentration, percent by weight.	xx
	Maximum specific gravity.	1.06
	Maximum ambient temperature.	110° F
	Installed location.	Outdoor
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Open
	Usable capacity (per tank).	5,000 Gal
	Tank diameter.	8 ft
	Straight shell length/height.	13.5 ft
	Maximum total length/height.	15.5 ft
	Recommended manufacturers.	Belding, Beetle, Tankinetics, Plasticon, Augusta, or equal
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	No
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	N/A
	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Gaskets.	EPDM
Accessories		
	Tank vent.	N/A
	Ladder required.	No

	Handrail required.	No
	Sight level gauge.	N/A
	Material for clear type, exterior tube.	N/A
	Material for clear type, interior wetted tube.	N/A
	Material for Magnetic flag type.	N/A
	Drawings for nozzle orientation.	Refer to Civil / Mechanical Drawings

Tank Nozzle Schedule

	Quantity	Connection	Location	Size (in)
	1	Tank fill from scum collection box	Side top	6
	1	Pump suction	Side bottom	3
	1	Manway.	Side bottom	24
	1	Level sensor.	Side bottom	3

Section 44 31 31

ODOR CONTROL BIOFILTER

1.0 ODOR CONTROL BIOFILTER SYSTEM REQUIREMENTS

This section outlines the requirements for the ODOR CONTROL BIOFILTER SYSTEM included as part of the wastewater treatment process. The process objective is to provide vapor phase odor control for the headworks systems, including the influent coarse screens, grit removal and fine screens, and the dewatering area.

1.1 SCOPE OF SUPPLY

1.1.1 GENERAL

At a minimum, the ODOR CONTROL BIOFILTER SYSTEM Quote shall include:

- Engineered media biofilter with humidification stage, if required to meet performance design criteria
- Odor control blower with sound attenuating enclosure
- Odor control damper
- Recirculation pump for humidification stage
- Foul air piping from Blower to Tower. Field piping to Blower Inlet flexible connector will be by others.
- Foul air piping system fittings, unless approved by the Design-Builder, including transition fittings and flexible connectors
- Standard instrumentation
- Control panel
- Water panel
- Nutrient storage and feed system
- All irrigation and nutrient system piping for a complete and operable system

The headworks odor control system shall be an engineered media biofilter system located immediately adjacent to the headworks. The headworks odor control system shall be sized to fit in the area allocated on the headworks drawings. Operation and maintenance manuals shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.1.2 CIVIL/STRUCTURAL

The odor control system shall be installed outdoors on slab-on-grade. Concrete, grout, anchorage, plumbing appurtenances, drain system, irrigation water supply, and other civil works will be provided by others.

1.1.3 ELECTRICAL & CONTROL

The plant Supervisory Control and Data Acquisition (SCADA) system will be provided by others. The Quote shall include electric motors, starters, power disconnect switches, and local control panels if they are part of manufacturer's standard control package offering. Equipment and instruments shipped loose for mounting in the field will be wired to the either the supplier's control panel or SCADA system by others.

1.1.4 MECHANICAL

Equipment and pipe within the odor control slab-on-grade boundary shall be within the Vendor's Scope of Supply. Equipment, pipe, and pipe supports for equipment and/or pipe outside the boundary shall be furnished and installed by others. The Vendor shall provide as part of the Quote any specific technical requirements for equipment, pipe, and/or pipe supports not provided by the Vendor.

Interconnecting piping between the headworks and odor control facility shipped loose for installation in the field will be furnished and installed by others. The Quote shall include a pipe schedule detailing Vendor supplied pipe, if any, and the Vendor's requirements for pipe supplied by others. The pipe schedule shall include pipe size, material, schedule, etc.

1.1.5 CONSTRUCTION, INSTALLATION & STARTUP

Installation of the Vendor's equipment will be by others. The Quote shall include a list of specific or unique items, if any, not provided by the Vendor that the Vendor deems necessary for installation.

Startup assistance and performance testing shall be part of the Scope of Supply. The Quote shall include rates for startup assistance broken down, at minimum, into:

- One time trip charges.
- Hourly personnel rates.
- Special equipment rates, if applicable.

1.2 PROCESS DESIGN CRITERIA

The attached datasheet(s) summarize the design requirements for the ODOR CONTROL BIOFILTER SYSTEM.

- Datasheet, Headworks, Odor Control
- Datasheet, Headworks, Odor Control, Blower

The datasheet(s) include the minimum information required to define the ODOR CONTROL BIOFILTER SYSTEM process requirements. The minimum performance requirement is 99% removal of overall Hydrogen Sulfide or 0.1 ppm maximum outlet concentration, whichever is greater. All other requirements listed in the datasheet(s) are listed as for informational purposes. Supplier shall provide a system that meets the minimum performance requirements. The Quote shall include the Vendor's standard offering that best corresponds to the conditions listed in the bid documents. The Vendor shall fill in all remaining information and add additional information to the datasheet(s) as required to describe the technical details of the Vendor's offering.

All process equipment fastening and anchorage materials shall be 316L Stainless Steel unless otherwise specified in the bid documents or unless the Vendor design stipulates another material for technical reasons.

44 31 31 Headworks Odor Control - Datasheet 1

Category	No.	Description	Units	Data
GENERAL	1	Tag Number		TBD
	2	Equipment Name		Headworks Odor Control
	3	P&ID		23-I-001
	4	Area Classfication		Class 1, Division 2, Group D
	5	Airstream Temperature, Average	°F	60
	6	Installation		Outdoor, Slab-On-Grade
PROCESS REQUIREMENTS	7	Duty		1 x 100% (1 duty, 0 standby)
	8	Equipment Type[5]		Biofilter, Two Stage (Stage 1 Humidification/Stage 2 Odorant Removal)
	9	Airflow Rate	cfm	830
	10	Inlet Hydrogen Sulfide Concentration, Ave	ppm	20
	11	Inlet Hydrogen Sulfide Concentration, Max	ppm	100
	12	Hydrogen Sulfide Removal Efficiency, Minimum[1]	%	99
	13	Maximum Outlet Hydrogen Sulfide Concentration[1]	ppm	0.1
	14	Empty Bed Residence Time, Stage 1[5]	sec	2
	15	Empty Bed Residence Time, Stage 2[5]	sec	30
	16	Media Type, Stage 1		Synthetic, structured
	17	Media Type, Stage 2		Engineered, inorganic
	18	Media Bed Depth, Min	ft	TBD
	19	Pressure Differential across Biofilter, max	in. WC	6
	20	Recirculation Flow Rate[5]	gpm	TBD
	21	Makeup Water Flow Rate[5]	gpm	TBD
	22	Irrigation Water Flow Rate[5]	gpm	TBD
MECHANICAL	23	Vessel Material		FRP
	24	Vessel Diameter, Max, as required to fit within footprint	ft	10
	25	Vessel Height (Excluding Exhaust Stack), Max	ft	10
	26	Recirculation Pump Motor Power, Max	hp	TBD

NOTES	No.	Note
	1	The more stringent of the H_2S removal parameters shall apply. The removal efficiency is based on the average inlet concentration.
	2	A separate blower datasheet will be provided. The Vendor shall complete the blower datasheet based on the Vendor's offering.
	3	Vendor shall size the headworks odor control system to fit in the space allocated in the headworks drawings.
	4	The minimum performance requirement is 99% removal of overall Hydrogen Sulfide or 0.1 ppm maximum outlet concentration, whichever is greater. All other requirements listed in the datasheet(s) are optional.
	5	As required to meet to meet the performance requirements.

HEADWORKS ODOR CONTROL BLOWER
44 31 31 DATA SHEET 2

APPLICABLE TO: ● PROPOSAL ○ PURCHASE ○ AS BUILT

For: City of Morro Bay, CA
Site: Morro Bay New WWTP
Service: Headworks Odor Control
● Continuous ○ Intermittent ○ Standby
Mfg. Model/No.Stgs.

Unit
Serial No.
No. Required: 1
Driver Type
Driver Item No.

NOTE: ○ Info. Normally by the Purchaser ☐ By Mfg. ◇ By Mfg or Purch

◇ OPERATING CONDITIONS

	NORMAL	RATED	OTHER CONDITIONS A	B	C	D
● Gas Handled (see sheet 2 of 3)	Air	Air				
● Volume Flow (SCFM - 14.7 psia @ 60°F)	830.00	830.00				
○ Weight Flow (lb/min) ○ Wet ○ Dry						
INLET CONDITIONS						
● Pressure (psia)	14.70	14.70				
● Temperature (°F)	65 to 85	65 to 85				
● Relative Humidity %	Up to 100%	Up to 100%				
○ Molecular Weight(lb/lbmol)						
☐ Cp/Cv(K_1)or(Kavg)						
☐ Compressibility(Z_1)or(Zavg)						
☐ Inlet Volume (CFM) ○ Wet ○ Dry						
DISCHARGE CONDITIONS						
● Pressure (psia)	Per Vendor	Per Vendor				
☐ Temperature (°F)						
☐ Cp/Cv(K_2)or(Kavg)						
☐ Compressibility(Z_2)or (Zavg)						
PERFORMANCE						
☐ BHP (All Losses Incl.)						
☐ Speed (RPM)						
☐ Estimated Surge (ICFM at Speed Above)						
☐ Adiabatic Head (ft)						
☐ Adiabatic Efficiency (%)						
○ Guarantee Point						
☐ Performance Curve No.						

○ PROCESS CONTROL

○ Blow-Off ○ Bypass From Discharge to
Valve By ○ Purchaser ● Vendor
Inlet Guide Vanes By ○ Purchaser ● Vendor ○ None
Inlet Throttling By ○ Purchaser ● Vendor ○ None
Disch. Throttling By ○ Purchaser ● Vendor ○ None
○ Speed Variation From to RPM

○ SURGE CONTROL

○ Blow-Off ○ Bypass From Discharge to
Valve By ○ Purchaser ○ Vendor
Surge Controls by ○ Purchaser ○ Vendor
Controller Mfr Model
Surge Sensors by ○ Purchaser ● Vendor

○ SITE AND UTILITY DATA

Location ○ Indoor ○ Under Roof ○ Heated
● Outdoor ○ Grade ○ Unheated
Unusual Conitions ○ Dust ○ Fumes
Electrical Area ● Non-Hazardous
Classification Class 1 Group D Div. 2
Elevation (ft) 132.00 Barometer (psia) 14.70

Range of Ambient Temperatures (°F)

	Dry Bulb	Wet Bulb
Site Rated	<ENTER>	
Normal	60	
Maximum	106	
Minimum	24	

Remarks:
1. Vendor to complete all available information in this datasheet based on the Vendor's design.
2. Vendor to provide sound attenuating enclosure for the blower.

Section 46 22 00

PACKAGED FINE SCREENS

PART 1 - GENERAL

1.01 SCOPE

A. This section covers two (2) tank mounted rotary perforated plate screens for removing floating, particulate, or fibrous material and transferring washed and dewatered screenings to a screw conveyor as shown on the Drawings and described herein. Screening units are designated as follows.

Equipment designation.	Packaged Fine Screens
Number of units.	2
Equipment tag numbers.	SCR-SCR-1101 SCR-SCR-1201
Equipment location.	Headworks Area

B. The equipment, material, piping, valving, ancillary systems, instrumentation, analyzers, and services specified in this section shall be designed, integrated, and provided as a cohesive and fully-functional system by a single Original Equipment Manufacturer (OEM), hereafter referred to as the Packaged Fine Screen Supplier (PFSS). Tank mounted fine screens shall be designed and furnished as complete systems requiring minimal on-site assembly, connection, or terminations. The PFSS shall provide a screw conveyor with chute to convey screenings from the Packaged Fine Screens to the discharge location as shown on the Drawings.

1.02 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

B. Coordination. The PFSS shall coordinate all details of the equipment with screening conveyor, including verification that all structures, piping, wiring, and equipment components are compatible.

C. Manufacturer's Experience. Unless specifically named in the Specifications, a manufacturer shall have furnished equipment of the type

and size specified which has been in successful operation for not less than the past 5 years.

D. Workmanship and Materials. PFSS shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

1. All equipment shall be designed, fabricated, assembled, and installed in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

2. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.

E. Power Supply. Unless otherwise indicated, power supply to the equipment will be 480 volts, 60 Hz, 3 phase. If other voltage levels are required other than 480Vac, transformers shall be furnished as required.

1.03 SUBMITTALS

A. Drawings and Data. Complete assembly and installation drawings, together with detailed specifications and data covering materials used and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals section. Each drawing shall be identified with the corresponding screen number.

The drawings shall include separate wiring diagrams for each screen and its electrical control equipment. Contractor shall provide the following information:

1. Fine Screens
   a. Name of manufacturer.
   b. Type and model.
   c. Number of units.
   d. Speed.
   e. Screen size.
   f. Net weight.

g. Drive unit.
h. Power supply.
i. Data on shop painting.
j. Anchor bolt details.
k. Detailed fabrication drawings.
l. Control component data.

2. Motors
   a. Name of manufacturer.
   b. Type and model.
   c. Rated size of motor, hp and service factor.
   d. Insulation class and temperature rise.
   e. Full load rotative speed.
   f. Net weight.
   g. Efficiency at full load.
   h. Full load current.
   i. Locked rotor current.

3. Electrical & Control Panel

   a. Electrical & Control panel enclosure layout, dimensions, and weight.
   b. Electrical schematics and wiring diagrams.
   c. Overcurrent characteristics and details of motor control.
   d. Enclosure rating.
   e. Catalog and data sheets on all components.
   f. A recommended sequence of operation, including values and ranges for time delays, speeds, and other set points for use in the initial startup of the system.

B. Manufacturer's Certificates:

1. The PFSS shall be responsible to obtain and submit to Design-Builder for review and approval all manufacturer certificates and to see that the Scope of Work is performed in accordance with Manufacturers' requirements for all equipment furnished.

2. The PFSS representative shall certify in writing that the equipment or system has been installed in accordance with the Manufacturer's recommendations, that it has been inspected by a Manufacturer's authorized representative, that it has been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed, and that the proper electrical and mechanical connections and adjustments have been performed.

3. System Certification: The PFSS shall provide a written certification of proper installation of the System components, and for the System overall. The PFSS shall submit such certificates to the Design-Builder for approval.

C. Operation and Maintenance Manuals

1. The PFSS shall provide operation and maintenance (O&M) manuals for the rotary drum fine screen, drive motor, lubrication pump, valves, and instruments and associated appurtenances in accordance with the requirements of Submittal Procedures section.

1.04 REFERENCED STANDARDS

A. Reference to standards, specifications, manuals or codes of any technical society, organization, or association, or to the laws or regulations of any governmental authority, whether such reference be specific to, or by implication, shall mean the standard, specification, manual, code, laws, or regulations in effect on the last day for receipt of the proposal for the System.

B. The provisions of these specifications shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of these specifications and the provisions of any such standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in this specifications); the provisions of any such laws or regulations applicable to the performance of the work (unless such an interpretation of the provisions of this specifications would result in violation of such law or regulation).

C. No provision of any such standard, specification, manual, code, or instruction shall be effective to change the duties and responsibilities of Owner, PFSS, Design-Builder, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents.

D. The following, but not limited to, the reference standards listed hereinafter will apply to the Packaged Fine Screens and associated specified equipment.

1. American Society for Testing and Materials (ASTM)

i. ASTM A36 - Standard Specification for Carbon Structural Steel

2. American Welding Society (AWS)
i. AWS D1.0 – Welding in Building Construction for Gas-Tight Welding

ii. AWS D1.1 - Structural Welding Code Steel

3. Society for Protective Coatings (SSPC)
   i. SSPC SP-10 - Surface Preparation Specification No. 10 Near-White Blast Cleaning
4. American Bearing Manufacturers Association Standards (ABMA)
5. National Electrical Manufacturers Association (NEMA)
6. American Institute of Steel Construction (AISC)
7. National Electric Code (NEC)
8. Institute of Electrical and Electronic Engineers (IEEE)
9. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All of the equipment specified herein shall be furnished by the PFSS who shall be responsible for the satisfactory performance of the equipment.

B. All materials and equipment, which will become a part of the installed work, shall be new and unused.

C. Like items of equipment provided herein shall be provided by one PFSS in order to achieve standardization of facilities, operation and maintenance, spare parts and manufacturer's service.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Equipment shipping, storage and handling shall be in accordance with the general Terms and Conditions.

1.07 SPARE TOOLS AND SPARE PARTS

The PFSS shall provide spare parts per the general Terms and Conditions. The following shall be provided as a minimum:

- Any special tools required for installation or maintenance of any of the furnished equipment shall be furnished.
- A complete itemized price list of all recommended special tools, spare parts, and consumables shall be submitted.
- A set of recommended spare parts and consumables for system startup and testing shall be furnished.
- A set of recommended spare parts and consumables for one year of operation from Date of Substantial Completion or Acceptance of Final Testing, whichever is later, shall be furnished.

1.08 ACCEPTABLE MANUFACTURER

A. The following are the only acceptable PFSS: Kusters Zima, Huber, Smith & Loveless, Vulcan, Headworks Inc, Westech, Parkson, Duperon, and Hydrodyne.

PART 2 - PRODUCTS

2.01 SERVICE CONDITIONS

Each screen shall be suitable for the conditions listed in the Meteorological and Seismic Design Criteria section including the seismic zone and site elevation. It shall also be suitable for the following:

Liquid service.	Headworks (Coarse Screening and Grit Removal) Effluent
Site elevation, above mean sea level.	127 ft

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. The screening equipment shall perform under the following conditions:

Channel width.	Minimum 3 ft
Operating floor elevation.	See Drawings ft
Elevation of channel floor upstream of screen.	TBD by PFSS ft
Elevation of channel floor downstream of screen.	TBD by PFSS ft
Height of screenings discharge above operating floor.	120 in
Screening perforation.	2 mm
Nominal screening basket diameter.	TBD by PFSS in
Minimum nominal screenings conveyor diameter.	10 in
Average flow through each screen.	0.97 mgd
Maximum flow through each screen	1.88 mgd

Minimum flow through each screen	0.28 mgd
Maximum differential head.	8 in
Maximum upstream high liquid level (at maximum flow).	See Drawings ft
Minimum downstream low liquid level (at minimum flow).	See Drawings ft
Minimum Free Board at Maximum Flow	2 ft
Drive motor.	Maximum 2 hp
Maximum wash water flow rate available.	55 gpm

B. Each unit of screening equipment shall be designed to withstand, without damage or permanent distortion, the maximum specified differential head at any channel water depth.

All components of the Packaged Fine Screens shall be covered for odor control. Odor control covers shall be 316 SS or FRP and provide with suitable sealing gaskets and latches to maintain a good seal and hold the panels securely in place during operation and against wind and weather. Odor control outlets shall be flanged for connection to PVC odor control suction piping by Design-Builder. Outlets shall be located to not require dissemble of connected odor control piping to remove covers and access the basins to the maximum extent possible. In cases where this cannot be achieved, PFSS shall coordinate alternate outlet nozzle connection detail with Design-Builder to facilitate easy access to basins and equipment. Design-Builder will furnish an odor control system with PVC suction piping sized per the Odor Control section.

1. Screen

   a. The rotary perforated plate screen shall be designed and built to withstand static and hydraulic forces exerted by the liquid to the screen. All structural and functional parts shall be sized for the loads encountered during the screening, conveying and pressing operations. All submerged components and all components of the rotary perforated plate screen in contact with the screened solids shall be of 316 stainless steel construction.

   b. The screen basket shall be of a cylindrical shape. The perforations shall go around the entire basket.

   c. The nominal perforation size shall be as noted in Paragraph 2.02. Bar screens or wedge wire will not be an acceptable screen media.

d. The rotating screen basket upper support ring shall be a minimum of $^{3}/_{8}$ inch thick and shall be machined to match the transport tube main support flange to ensure proper alignment of the basket. Designs which do not provide this machined main upper support ring will not be acceptable. The main screen basket lower support ring shall be $^{6}/_{10}$ inch minimum.

e. The basket diameter shall be matched with a sufficient number of clear openings to ensure the maximum flow rate is achieved and to provide less than the maximum headloss noted in Paragraph 2.02.

f. The width of the screening channel shall be as noted in Paragraph 2.02.

g. A protective guard shall be provided to cover the exposed top of the screen basket.

2. Rotating Basket and Cleaning Brush

a. The rotating basket assembly shall be cleaned by a stainless steel high pressure spray bar and a backed nylon brush with bristles that penetrate the depth of the perforated screen to ensure positive screenings removal. Brush bristles shall be high-strength nylon for superior life.

b. The screen basket shall continuously rotate in one direction and pass through the topmost position were it shall be cleaned by the stainless steel backed cleaning brush and the spray bar. The brush shall be designed to ensure cleaning of the spaces to the full depth of the perforations. The cleaning brush shall be mounted upon a holding device which keeps the brush in constant contact with the basket and will automatically adjust to allow for brush wear.

c. The rotating basket and the screw conveyor shall be fixed to the same shaft and driven by a common drive.

d. A stainless steel backed nylon brush shall be attached to the rotating basket and positioned to make contact with the screening trough to sweep material caught on the edges of the trough.

3. Screenings Conveyor and Screenings Dewatering Press

a. The screenings screw conveyor transport tube nominal diameter shall be as noted in Paragraph 2.02 with a minimum wall

thickness of 1/10 inch (<780=1/10). A minimum of two (2) anti-rotation bars with ¼ inch minimum thickness and 1 1/5 inch wide shall be welded to the inside of the transport tube along the longitudinal axis. The screenings screw conveyor shall not depend on support from the anti-rotation bars during normal operation.

b. A 4/5 inch minimum thickness basket support plate flange shall be attached to the screenings transport tube to attach the screen basket rollers and to provide for attachment of the screenings collection hopper. A ½ inch minimum thickness drive support flange shall be welded to the upper end of the screenings transport tube for attachment of the drive assembly. The basket shall be mounted to the machine via a solid support arm at the lower end of the basket which bolts directly to the screenings transport shaft. A series of roller bearings will support the top end of the basket (<780=3 rollers).

c. The dewatering screw shall be designed to transport and dewater the screened material. Screw flights shall be of decreasing pitch approaching the compaction zone to provide a pre-dewatering stage and shall have a minimum thickness of 3/16 inch.

d. The upper and lower screw conveyor torque tube shall be fitted with solid stub shafts. Stub shaft and screw conveyor torque tube shall be accurately machined to allow a shrink-fit design.

e. A compaction zone shall be an integral part of the screenings screw conveyor and transport tube design. The compaction zone shall be designed to form a screenings plug of material and to return water released from the screened material back to the wastewater channel through circular holes that are machined into the screenings transport tube.

f. The compaction zone housing shall be furnished with a bolted access cover with gasket, as well as a bolted dewatering section panel, to allow access to the screw conveyor. Designs which require removal of the drive assembly, discharge head, or screw conveyor to gain access to the compaction zone will not be acceptable.

4. Drive

a. The basket mechanism and transport screw shall be driven by a shaft mounted geared motor. The geared motor shall have a

minimum service factor of 1.0 equivalent to an AGMA Class I rating.

5. Spray Wash Systems

   a. Automatic spray wash systems shall be provided for the screens and shall be constructed of a minimum of 1/2-inch diameter minimum piping and flexible reinforced PVC hose. Spray wash systems shall be operated only while the screen basket is rotating. The spray wash system shall include a solenoid valve for flow control.

   b. The screenings spray wash systems shall be designed for water supply noted in Paragraph 2.02.

   c. The dewatering section shall be provided with a ring flush water header system to ensure complete flushing of the compaction zone. Header design shall be oriented to completely wash the full surface of the transport tube drainage area.

   d. The solenoid valves shall be operated via the programmable controller and/or manually.

C. The equipment shall be so arranged that all components can be serviced from the operating floor. All components shall be balanced so that jamming at any point will not result in structural failure, but will cause the drive motor to stall.

D. All components, including the gear reducer, shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor.

2.03 MATERIALS

A. Construction materials shall be specified and as follows:

Screen Basket	Stainless steel, AISI Type 316.
Discharge Chute	Stainless steel, AISI Type 316.
Spray Wash Header and Nozzles	Stainless steel, AISI Type 316
Cleaning Brush	Nylon Bristles, Stainless steel hardware, AISI Type 316
Side Frames, Guides, Seal Plate	Stainless steel, AISI Type 316.

Pin Rack Bushings and Rollers	Carbon steel hardened and ground. Non-lubricated type.
Seal Gasket	Polyurethane
Shafting	Carbon steel, cold rolled, solid.
Bearings	Antifriction, rolling element type, grease lubricated.
Grease Line	Stainless steel tubing, ASTM A269, Grade TP 304, with stainless steel compression fittings; or stainless steel pipe, ASTM A312, Grade TP304, Schedule 40S, with threaded stainless steel fittings.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane; "Thred Gard Nickel"; Never-Seez "Pure Nickel Special;" or Permatex "Nickel Anti-Seize".
Anchor Bolts and Hardware	Stainless steel, AISI Type 316L.

2.04 DRIVE UNITS

A. Each screen screw conveyor and screen basket assembly shall be driven by an electric motor through a flexible coupling. Drive units shall be designed for 24 hour continuous service and shall be single speed.

B. Drive units shall be in full compliance with the specifications and shall be of the general type and arrangement regularly furnished by the named manufacturer. The drive unit shall be arranged to protect all screen components from overload and shall stop in the event the screen assembly engages an object which it cannot dislodge.

C. Gear Reducers. Gear reducers shall be as specified in the General Equipment Stipulations except that the use of permanently sealed, grease lubricated bearings will not be acceptable.

2.05 ELECTRICAL

A. A single 480Vac, 3 phase, power feed will be provided for each fine screen electrical panel. If other voltages other than 480Vac are required, transformers shall be provided with the electrical panel.

B. General. Electrical package including outdoor rated, air-conditioned, and NEMA rated according to the classified area electrical enclosure, motor starters, variable frequency drives, circuit breakers, disconnect switch, etc. shall be furnished and installed for the Packaged Fine Screens to provide a completely functional fine screening systems.

See electrical sections as identified in 01100 Section for electrical requirements

C. Electric Motor. See motor section as identified in 01100 Section for motor requirements.

D. Controls. Controls for the screen shall be furnished by the screen manufacturer. The fine screen system shall be furnished with the following items:

1. Main control panel.
2. Local control panels.
3. Local Control Stations
4. Limit switches.
5. Torque overload switch.
6. High Differential water float switch.

E. Electrical equipment in the screen area shall have NEMA rated according to the classified area.

F. The screen controls shall permit either manual or automatic operation of the unit.

G. Limit switches shall be provided for the following functions:

1. To alarm and stop operation for a torque overload.
2. The manufacturer shall provide other limit switches as needed for a complete and functional operating system.
3. The differential water level control system for the screen is specified in Pressure Level Instruments. When the system senses a predetermined head loss across the screen, an isolated contact will close as a signal to start the backwash cycle.

H. Main Control Panel. A stand-alone main control panel shall be provided for the Fine Screen System for automatic controls and monitoring, and plant interface. The main control panel shall be completely prewired and checked. The main control panel shall be provided with the following minimum requirements:

1. Programmable Logic Controller (PLC). The PFSS shall be responsible for the design of the Packaged Fine Screen control system. In addition, the Packaged Fine Screen control system programmable logic controller (PLC) system design shall have the capability of communicating with the plant control system (PCS) system to send and receive information over an Ethernet-based communication link. The PFSS shall coordinate addressing and data exchange with the

Engineer-Builder's System Integrator as specified in the Instrumentation and Control System section.

2. The control system supplied by the PFSS shall conform to the requirements of Section 01100.
3. The PFSS shall be responsible for the design of the process control logic for all equipment, systems, operations, alarms, and reporting systems required for the complete Packaged Fine Screen system.

I. Local Control Panel. A single control panel shall be furnished for each pair of screens and each pair of screen conveyors. The local control panels will be mounted in the adjacent to the Packaged Fine Screens. Each screen local control panel shall be and shall contain at a minimum the following devices:

Disconnect switch with door handle
Motor starter for each screen
Control transformer for each screen
Motor starter for each screen conveyor
Elapsed time meter for each screen
Transient voltage surge suppressor
Power on pilot light
Running pilot light for each screen
Running pilot light for each conveyor
Fault pilot light for each screen
Fault pilot light for each conveyor
Reset Switch
Emergency Stop button
Controller

J. The local control panel shall be provided with the following:

1. Motor starters shall be combination type, full voltage, reversing, not smaller than NEMA Size 1. Each starter shall include a circuit breaker, reversing magnetic contactor, overload relays, and a 480 volt to 120 volt, 60 Hz control power transformer with one lead fused and the other lead grounded.
2. Programmable controller shall communicate with the PLC in the main control panel via Ethernet.

K. Local Control Station. A local control station shall be provided per each screens and conveyors hardwired to its corresponding local control panel. Each local control station shall be provided with Local-Off-Remote (LOR), Forward-Off-Reverse (FOR), and Emergency Stop switches. The local control station shall be NEMA 4X enclosure mounted near the equipment.

L. System Operation. Each local control panel shall control two screens and two screen conveyors. With the Local-Off-Remote switch in Remote (on the local control station), the control panel shall receive a signal from the PLC to run. With the Local-Off-Remote switch in Local, the screen shall be controlled by Start/Stop push buttons on the local control panel and at the screen.

The emergency stop push button shall stop the screen in any control mode.

M. Device Identification. Equipment, identification and tagging shall be per the Equipment and Valve Identification section, per the Scope of Work section, and as specified herein. Equipment identification numbers and tags shall be provided for all equipment furnished by the PFSS including:

a. Packaged Fine Screens
b. Screw Conveyors

2.06 FABRICATION

A. Assembly Fasteners. All bolts, nuts, and washers shall be stainless steel.

B. Edge Grinding. Sharp projections of cut or sheared edges of ferrous metals, except stainless steel, which will be submerged in operation and are not to be welded, shall be ground to a radius as required for satisfactory paint adherence.

C. Stainless Steel. All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication including welded areas shall be repickled or passivated in accordance with ASTM A380 as needed to remove all traces of iron contamination. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2.07 WARRANTY

A. All the equipment supplied by PFSS shall be warranted by the PFSS in accordance with the Terms and Conditions in this procurement package.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation will be in accordance with PFSS recommendations and as specified herein.

3.02 FIELD QUALITY CONTROL

3.02.01. INSTALLATION CHECK

An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily and in accordance with the specified performance requirements.

All costs for these services shall be included in the contract price.

3.02.02. EQUIPMENT SHOP/FACTORY TESTS AND INSPECTION

PFSS shall submit documentation of shop and factory tests proposed for the Packaged Fine Screen system and its components. The Design-Builder and/or Owner representatives shall be permitted to conduct shop inspections or witnessing of any shop testing at their choice at their cost.

The Design-Builder shall witness Factory Acceptance Testing of the Packaged Fine Screen to verify proper system function and setup for interoperability with the PCS prior to releasing the equipment for shipment to the site. The Design-Builder shall also inspect the Packaged Fine Screen system equipment at that time to verify it is suitable for shipment to the site. PFSS is not responsible for Design-Builder travel costs for this trip.

3.03. STARTUP AND FIELD TESTING

3-3.01. Onsite Functional Testing. The PFSS and Design-Builder shall conduct functional testing of all Packaged Fine Screen System equipment. Functional testing shall include, but not be limited to, the following activities:

1. Manufacturer's certifications of proper installation have been accepted by the Design-Builder.
2. Leakage tests, electrical tests, and adjustments have been completed.
3. Individual instrumentation loops (analog, status, alarm, and control) have been verified functionally.
4. Pressure switches, flow switches, timing relays, level switches, process analyzers, pressure regulating valves, and other control devices to the settings determined by the PFSS have been adjusted for accuracy and have been field calibrated or been provided with a calibration certificate.
5. Individual interlocks between the field-mounted control devices and the motor control circuits, control circuits of variable-speed controllers, and packaged system controls have been verified. This includes verifying communications and programming interfaces between the Packaged Fine Screen PLC and the PCS/SCADA system.

PFSS will remove and replace all defective equipment, components and systems supplied by the PFSS at no cost to Design-Builder, the operator or the owner. All costs will be borne by the PFSS.

3-3.02. Startup of the Packaged Fine Screen System. The PFSS will assist the Design-Builder with the startup of the Packaged Fine Screen system. The PFSS will assist the Design-Builder with the operation of the Packaged Fine Screen System during startup.

The Design-Builder will be responsible for startup of the Packaged Fine Screen System components as in coordination with the PFSS who will assist the Design-Builder with startup of the combined Packaged Fine Screen System.

3-04. ONSITE PACKAGED FINE SCREEN SYSTEM ACCEPTANCE TESTING

3-4.04.A. Overview of Onsite Acceptance Test. The objective of the onsite Acceptance test is to validate the design, installation and operation of the Packaged Fine Screen system in accordance with the guarantees and warranties provided by the PFSS.

3-4.04.B. PFSS Responsibilities During the Onsite Acceptance Test. The PFSS responsibilities during the onsite Acceptance test include, but are not limited to:

1. Ensure that all mechanical, electrical and I&C equipment for the Packaged Fine Screen system are fully tested and debugged prior to the start of the Onsite Acceptance Test.
2. Review daily operating data during the Acceptance test and provide the requisite support to the Design-Builder and site personnel as required. Ensure that equipment failures are resolved in a timely manner.

3. Compile a final Acceptance test report for the Packaged Fine Screen system summarizing all activities, tests, results and conclusions.
4. Provide the necessary assistance on all issues relevant to the Packaged Fine Screen system on a case-by-case basis.

3-4.04.C. Design-Builder Responsibilities during the Onsite Acceptance Test. The Design-Builder's responsibilities during the onsite Acceptance test include, but are not limited to:

1. Coordinate operations personnel (to be provided by Owner).
2. Coordinate or provide utilities for plant operation.

3-4.04.D. Schedule and Duration of Onsite Acceptance Test.

1. The onsite Acceptance test shall be carried out after successful completion of the Onsite Functional Test of the Packaged Fine Screen system, startup and functional testing of all other systems in the Morro Bay WRF.
2. Duration of Onsite Acceptance Test = 2 days (1 day per Packaged Fine Screen).
3. When failure, shutdown, or interruption occurs, the test shall be terminated and corrective action undertaken by the PFSS or by the Design-Builder, depending on the source of failure, shutdown, or interruption.
4. Upon resumption of operation, the Acceptance Test will be restarted on a date mutually agreed to by the Owner, Design-Builder and the PFSS with no credit given for the operating time achieved before the system failed, shut down, or was otherwise interrupted, if the failure, shut down or interruption is the PFSS' responsibility.
5. Testing shall be conducted by the Design-Builder and representatives from the PFSS, with the assistance of the Design-Builder and the Owner's operation and maintenance staff. Any labor required for the testing that is above normal plant operating requirements shall be provided by the Design-Builder and paid for separately by the PFSS.
6. Within 20 days following completion of Acceptance testing, the PFSS shall submit a written report summarizing the test and all data and results.

3-4.04.E. Onsite Acceptance Test Protocol.

1. A detailed onsite Acceptance test protocol shall be jointly developed by Design-Builder and the PFSS at least 90 days prior to the Onsite Acceptance Test.
2. The detailed Acceptance testing protocol shall provide information on the following:

- Acceptance testing conditions and durations proposed by the PFSS.

3-4.04.F. Onsite Acceptance Test Acceptance Criteria.

A. The Packaged Fine Screen system will be accepted only if all the following acceptance criteria are fully satisfied during the Acceptance testing period:

- Water levels and flows specified in Paragraph 2.2 in this section are achieved and observed to the extent possible in coordination with the Design-Builder and Owner.
- All captured screenings from the screen discharge into dumpster receptacles.
- Packaged Fine Screen effluent is observed by the Design-Builder to be consistent with the performance requirements.

3-05. TEST REPORTS. The equipment manufacturer shall prepare a test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder after completion of the specified tests.

3-06. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer’s expense.

3-07. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-07.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-07.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 46 41 23

SUBMERSIBLE MIXERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of submersible propeller mixers as specified herein. Each mixer shall be provided with a submersible electric motor, a motor mounting bracket for installation, a control panel, and all other appurtenances specified or otherwise required for proper operation.

Equipment designation.	BNR Anoxic Zone Mixers	BNR Deox Zone Mixer	Sludge Holding Tank Mixers
Number of mixers.	2	1	2 (1/tank)
Mixer tag numbers.	BNR-MXR-1001, BNR-MXR-2001	RAS-MXR-0001	WAS-MXR-0101, WAS-MXR-0201
Mixer location.	BNR Anoxic Zone	BNR Deox Zone	Sludge Holding Tank

Each mixing unit shall be complete with a submersible electric motor and gear box, adjustable frequency drive, mounting assembly for installation, and all other appurtenances specified or otherwise required for proper operation, including special tools.

1-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Design-Builder. Definition of terms and other hydraulic considerations shall be as set forth in the Hydraulic Institute Standards.

Each unit shall be furnished complete with all anchors and supports, all mechanical equipment required for proper operation, and all additional materials or construction required by the manufacturer's design.

The mixing equipment specified herein shall be designed and manufactured by a single manufacturer which shall have sole responsibility for the equipment. The manufacturer shall have mixing equipment of this design and of comparable capacity in successful operation in the field.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this

specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.04. Identification. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1-2.05. Spare Parts. A list of recommended spare parts shall be provided by the manufacturer.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials used, parts, devices, and other accessories forming a part of the equipment furnished as well as the proposed performance test procedure, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Submersible Mixers

- Name of manufacturer.
- Type and model.
- Tag number and mixer designation.
- Mixer Location.
- Rotative speed.
- Type of bearings.
- Net weight of submersible mixer and motor.
- Complete performance curves showing capacity versus speed, efficiency, and kW input.
- Data on shop painting.
- Anchor bolt details.

Motors

- Name of manufacturer.
- Type and model.
- Type of bearings and lubrication.
- Rated size of motor, hp.
- Temperature rating.
- Full load rotative speed.
- Net weight.

Efficiency and power factor at full load and rated operating

condition.
Full load current.
Locked rotor current.
Data on cable.
Moisture sensing protection characteristics, including wiring schematics.

Variable Frequency Drives

As specified in the Variable Frequency Drives section.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operations and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The mixers shall be capable of completely mixing the liquid in the BNR Anoxic zone containing mixed liquor and also in the Sludge Holding Tanks containing Waste Activated Sludge. Mixers shall be suitable for the following conditions:

Basin application.	BNR Anoxic Zone	BNR Deox Zone	Sludge Holding Tank	
Liquid(s) to be mixed.	Mixed Liquor	Return Activated Sludge	Waste Activated Sludge	
TSS Concentration	5,000-8,000	6,500-10,000	6,500-10,000	mg/L
Liquid temperature range.	18-24	18-24	18-24	°C
Influent and recycle mixed liquor to be mixed together.	No	No	No	
Average flow rate.	2 mgd/zone[1]	3 mgd	26 gpm	
Seismic design requirements and site elevation.	See Meteorological and Seismic Design Criteria section			

1. Includes RAS and influent flows

The propeller mixers shall be provided with a mounting system which enables the mixer to be raised, lowered, and easily removed without the need for personnel to enter the basins.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. The mixers shall be designed for operation in the basins and storage tanks as indicated on the Drawings.

The mixers in the BNR tanks are used to keep the MLSS from settling. The mixers in the sludge tanks will alternate on and off with coarse bubble aeration to keep the sludge well-mixed as the tank levels vary.

Mixer Tag Number.	BNR-MXR-1001, BNR-MXR-2001	RAS-MXR-0001	WAS-MXR-0101, WAS-MXR-0201	
Nominal basin dimensions.	See drawings	See drawings	See drawings	ft
Water depth			Varies	
At average flow	18.5	18.5	6 - 20	ft
At maximum month flow	18.9	19.0	6 - 20	ft
At peak flow	19.2	19.3	6 - 20	ft
Liquid volume to be mixed.	4300	1000	N/A	ft^3
Maximum power input	2.0	2.0	N/A*	bhp
Thrust/momentum	30 to 120	5 to 20	N/A*	N
Mixer speed requirements.	Variable Speed	Variable Speed	Variable Speed	
Maximum propeller diameter.	15	15	15	in
Mixer mast and hoist required	Yes	Yes	Yes	

The propeller water horsepower requirements, gear losses, and an ample allowance for buildup on the propeller of the mixer shall be included in determination of the brake horsepower requirements.

2-3. ACCEPTABLE MANUFACTURERS. The submersible propeller pumping equipment shall be as manufactured by Flygt Corporation, Landia, ABS, KSB, or equal.

2-4. MATERIALS.

Mixer Mast Assembly	
Mast Brackets (Upper, Intermediate, and Lower).	Stainless steel, AISI Type 316.
Mast.	Stainless steel, AISI Type 316.
Lifting Cable.	Stainless steel, AISI Type 316.
Retaining Chain.	Stainless steel, AISI Type 316.
Lifting Bracket or Bridle Chain.	Stainless steel, AISI Type 316.
Mixer	
Stator Housing and Oil Chamber.	Stainless steel, AISI Type 304 or 316
Propeller Shaft.	Alloy steel, hard chrome plated; or stainless steel AISI Type 316.
Propeller Shaft Mechanical Seal.	Stainless steel with tungsten carbide or silicon carbide rings.
Motor Shaft Mechanical Seal.	Stainless steel with tungsten carbide or silicon carbide rings.
Propeller Blades.	Same as stator housing.
All Assembly Fasteners	Stainless steel, AISI Type 316.
Coatings (Primer and Finish Coat).	
Epoxy	PPG Amercoat "Amercoat 385 Epoxy", Carboline "Carboguard 890", ICI Devoe Devran "224HS", Tnemec "Series N69 Hi-Build Epoxoline II", or Sherwin-Williams "Macropoxy 646".

Note: The manufacturer's coating recommended for the specified service that is equivalent to the specified coating will be acceptable.

Where stainless steel components are welded, the stainless steel shall be AISI Type 316L.

All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped. Pickling shall produce a modest etch and shall remove

all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces contaminated or damaged during fabrication including welded areas shall be repickled or passivated in accordance with ASTM A380 as needed to remove all traces of iron contamination and heat tint. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2-5. CONSTRUCTION.

2-5.01. Mixing Unit. The mixing unit shall be of the close-coupled**,** direct driven or integral-gear driven submersible type. All components of the mixer, including motor and gear box, shall be designed for the specified service conditions and be capable of continuous underwater operation.

A sliding guide bracket shall be an integral part of the mixer unit. The entire weight of the mixer unit shall be guided by a single bracket which shall be capable of handling all thrust created by the mixer.

Cast components, shall have smooth surfaces devoid of blow holes and other irregularities.

2-5.02. Propeller. Each propeller shall have a certain number of blades as determined by the mixer supplier, each integrated with a stainless steel shaft for mounting in a cast iron or stainless steel hub. The blades shall be dynamically balanced and of non-clogging backward curve design.

2-5.03. Oil Chamber Housing. The oil chamber shall contain an inspection plug, drain plug, and vent plug.

2-5.04. Mechanical Seals. Each mixer shall be provided with a lapped end face type mechanical seal (propeller shaft) and two lip seals (gear box for gear-driven mixers), running in oil reservoirs for cooling and lubrication. The mechanical seal between the propeller and propeller shaft oil chamber shall contain one stationary and one positively driven rotating face ring running in an oil reservoir for cooling and lubrication. The seals between the shaft and gear box, and gear box and motor chamber shall be of the lip style. All seal springs shall be isolated from the pumped liquid.

Four seals separating the various parts as specified herein will also be acceptable. The outer seal in the propeller hub shall be either a viton or nitrile rubber lip seal, sealing propeller shaft and grease chamber from the mixed media. The two inner seals on the propeller shaft shall be either viton or nitrile rubber lip seals insulating the propeller shaft grease chamber from the gearbox oil chamber. The fourth seal shall be a mechanical seal running in the oil for

cooling and lubrication. It shall be mounted on the motor shaft to insulate the gear box oil chamber from the dry motor stator housing.

The seals shall require neither maintenance nor adjustment, but shall be easy to check, relap, and replace. Neither shaft seals lacking positively driven rotating members, nor conventional double mechanical seals which use a common single or double spring and require a pressure differential to offset external pressure and effect sealing, will be acceptable.

2-5.05. Sealing of Mating Surfaces. All mating surfaces shall be machined and fitted with nitrile rubber O-rings where watertight sealing is necessary. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain gasket or seal compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

2-5.06. Mixer Mast Assembly. A mixer mast assembly shall be provided for each installed mixer and shall be used to mount the mixer during operation and to guide the unit during installation and removal from service. The assembly shall include an upper mast bracket, hoist, mast, intermediate mast bracket, lower mast bracket, lifting cable, and retaining chain.

2-5.06.01. Upper Mast Bracket. The upper mast bracket shall connect the top of the mast to the structure and shall include a hoist socket and position locking plate. The upper mast bracket shall be constructed with a position locking plate in conjunction with a lock pin to positively lock the mast in place at various operating angles and allow rotation of 180 degrees of the hoist and mast about a pivot point.

2-5.06.02. Manual Hoist. Each mixer assembly shall be provided with one manual hoist with a load rating as indicated. The hoist shall raise and lower the mixers for installation and service. The hoist shall consist of a mast, davit arm, and hand winch, and AISI Type 316 stainless steel lifting cable, with diameter and length as indicated in the Mixing Mast Assembly Design Requirements. The hoist shall be constructed of AISI Type 316 stainless steel and shall be mounted to the upper mast bracket. The davit arm shall center the lifting cable over the mixer. A folding handle, permanently attached to the mast, shall be provided to rotate the mast, mixer mast, mixer, and hoist assembly as one unit about the pivot point. A hand winch shall be attached to the mast or davit arm and shall be equipped with a disc brake for load control.

The hoists shall be capable of being moved to any mixer location and shall not weigh more than 225 pounds. Suitable lifting handles shall be provided.

The mixer mast assembly shall be compatible with the hoist and provide a lifting cable quick disconnect feature, Flygt "Grip-Eye", or equal.

2-5.06.03. Mast. The mast shall be constructed of structural tubing, extending from the lower mast bracket to the upper mast bracket. The size of the tubing shall be as specified herein.

The intermediate mast bracket shall support and connect the mast to the structure wall, and shall include a mast pivot pin.

The lower mast bracket shall support the entire weight of the mixer mast, mixer, and hoist assembly, shall connect the mixer mast to the floor, and shall include a mast pivot pin.

2-5.06.04. Lifting Cable. The mast assembly shall include a lifting cable, of the same size specified for the hoist cable, which will connect to the hoist lifting cable using the quick disconnect feature as previously specified.

The power cord shall be tethered to the lifting cable using stainless steel hardware. The tether hardware shall include heavy-duty rubber hose to protect the power cord and, sliding carabiner that allows power cord to slide freely on the lifting cable.

The lifting cable shall be attached to the mixer with a lifting bracket or bridle chain which will allow the lifting cable to be centered over the mixer. A stainless steel bridle chain shackle shall be provided to connect the lifting cable to the lifting bracket or bridle chain.

2-5.06.05. Retaining Chain. A retaining chain shall extend from the top of the mixer mast to the mixer, and shall allow the mixer to be located at any intermediate point on the mast. The retaining chain shall be connected to the top of the mast with a stainless steel shackle. The shackle shall allow adjustment of the retaining chain to fix the mixer at any intermediate position on the mast. The bridle chain shackle shall connect the retaining chain to the mixer.

2-5.06.06. Mixing Mast Assembly Design Requirements. The hoist and mast shall be designed to meet the following:

Tag Number.	BNR Deox Mixer RAS-MXR-0001	BNR Anoxic Mixers BNR-MXR-1001, BNR-MXR-2001	Sludge Holding Tank Mixers WAS-MXR-0101, WAS-MXR-0201

Hoist load rating.	TBD by mixer supplier	TBD by mixer supplier (one removable hoist to share with the two mixers)	TBD by mixer supplier (one removable hoist to share with the two mixers)	lb
Hoist lifting cable diameter.	TBD by mixer supplier	TBD by mixer supplier	TBD by mixer supplier	in
Hoist lifting cable length.	TBD by mixer supplier	TBD by mixer supplier	TBD by mixer supplier	ft
Mast structural tubing size.	TBD by mixer supplier	TBD by mixer supplier	TBD by mixer supplier	

2-5.07. Bolts and Nuts. Field assembly bolts and nuts and anchor bolts and nuts shall be provided for each item of equipment. Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2-6. FABRICATION AND MANUFACTURE.

2-6.01. Welding. All welded joints which will be fully or partially submerged shall be sealed watertight with continuous welds.

2-6.02. Edge Grinding. Sharp projections of cut or sheared edges of ferrous metals which will be submerged during operation shall be ground to a radius as necessary to ensure satisfactory paint adherence.

2-6.03. Surface Preparation. All welds shall be thoroughly cleaned and ground smooth in preparation for painting. All ferrous metal surfaces, except motors, speed reducers, and stainless steel, shall be solvent cleaned in accordance with SSPC-SP1 before shop primer is applied.

2-6.04. Shop Painting. All iron and steel parts, except for stainless steel parts, which will be in contact with liquid or submerged after installation shall be shop cleaned in accordance with the coating manufacturer's recommendations and painted with an epoxy coating system. The coating shall have a dry film thickness of at least 10 mils [250 µm] and shall consist of a prime (first) coat and finish coats. At least one quart of the finish coat material shall be furnished with each mixer for field touchup painting.

All ferrous metal surfaces which will not be submerged or in contact with liquid, except motors, speed reducers, and stainless steel, shall be given a shop coat of universal primer and final coating per Manufacturer’s standard.

See the General Equipment Stipulations for other shop painting requirements.

2-7. BALANCE AND VIBRATION. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable at normal operating speed. Excessive vibration shall be sufficient cause of rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

2-8. DRIVE UNITS.

2-8.01. Electric Motors. Each propeller mixer shall be driven by a totally submersible, electric motor manufactured and furnished by the mixer manufacturer. Motor nameplate rating shall exceed the maximum power required by the mixer at the operating range. Each motor shall be rated for the power supply provided to the mixer, and shall have a service factor of 1.10. The stator housing shall be an air-filled, watertight casing. A cooling jacket shall encase the motor housing for each mixer where needed to maintain adequate cooling. The cooling jacket shall require no external source of cooling water. Motor insulation shall be moisture resistant, Class F, 155°C. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature, and designed for at least 10 starts per hour.

The motor bearings shall be antifriction, permanently lubricated type. The bearings shall have a calculated ABMA L_{10} Life Rating of 40,000 hours when operating at maximum operating point. Maximum shaft run-out at the mechanical seals shall not exceed 2 mils at any point in the operating range.

The water seal design for cable entry shall not require a specific fastener torque to ensure a watertight and submersible seal. The use of epoxies, silicones, or other secondary sealing systems will not be acceptable. The cable entry junction box and motor shall be separated by a stator lead sealing gland or terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

Each mixer shall be provided with a separate or combined submersible power cable and submersible control cable. The power cable shall contain a ground conductor and one conductor per power phase. All submersible cables shall have a legend or code permanently embossed on the cable indicating the cable is suitable for submersible use. Cable sizing shall conform to NEC requirements. The cable lengths shall be sufficient to extend to the junction boxes specified below plus an extra 10 feet [3 m]. Each cable shall be provided with stainless steel Kellems grips and stainless steel support brackets to help prevent damage to the cable insulation.

Motors shall be specifically selected for service with an adjustable frequency type speed controller and shall be derated to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation so that the motor does not exceed Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by adjustable frequency drives shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

2-8.02. Variable Frequency Drives. The VFDs will be purchased separately outside of the mixer supplier scope of work.

2-9. MOTOR CONTROLS.

2-9.01. Junction Box. Each mixer shall be provided with a junction box for power and control cable termination. The junction box shall be mounted as indicated on the Drawings. The power and control cables to the mixer shall be terminated in the junction box. A Kellems grip or other suitable strain relief device shall be provided on each submersible cable to prevent excess strain between the submersible cable and the junction box.

The junction box shall be as specified in the Electrical section.

2-9.02. Moisture Detection System. Each submersible mixer housing shall be provided with a moisture detection system complete with all sensors, control power transformers if required, and relays. The moisture detection system shall be rated for a 120-volt ac supply voltage. If the system operates on a voltage other than 120 volt ac, the manufacturer shall provide the necessary control power transformer. The moisture detection system shall provide one normally open dry output contact rated 5 amps at 120 volts ac. The contact shall close when moisture is detected in the submersible mixer motor housing or motor pre-chamber as recommended by the equipment manufacturer. All moisture detection system components shall be furnished by the submersible mixer supplier and components not integral to the mixer shall be shipped loose for installation into the motor controller enclosure.

2-9.03. Temperature Detection System. Each motor shall be protected by one motor temperature switch embedded in each phase winding. Each switch shall be designed to operate at 125°C (±5°C). Each switch shall be normally closed automatic reset type rated 5 amps at 120 V ac. The switches shall be wired in series with end leads wired to terminals within the motor housing.

PART 3 - EXECUTION

3-1. INSTALLATION. Each unit shall be installed in accordance with Equipment Installation section and as specified herein.

Installation of the equipment shall be in accordance with the Hydraulic Institute Standards. Location, elevation, and the direction of the mixer (horizontal and vertical angle) shall be as determined by the manufacturer and accepted by Design-Builder.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-2.03. Preliminary Field Tests. Preliminary field tests, as described in the Equipment Installation and Startup Requirements sections, will be performed on equipment specified in this section. The following additional tests shall be conducted on the equipment specified in this section as part of the preliminary field tests.

After installation of the units, and after all accessories are in operable condition, a mechanical test will be performed by the Design-Builder under the supervision of the manufacturer. Each unit shall be submitted to complete normal start, normal stop, and emergency stop cycles. Each unit with a hoist system shall also be checked to ensure that the hoist and mixer mast assembly are installed properly and that each mixer can be removed from the basin without binding of the mixer on the mixer mast. For each unit with a hoist system the mixer, hoist, and mast shall be rotated 180 degrees about its pivot point. Each mixer with a hoist system shall be located and operated for 30 minutes at least two intermediate

points on the mast without any excessive movement or vibration as determined by Design-Builder.

3-2.04. Field System Operation Tests. Field system operation tests, as described in the Startup Requirements sections, will be performed on the equipment specified in this section. As an exception, the length of the test for equipment specified under this section shall be 30 days rather than 7 days as specified in the Startup Requirements section.

3-3. PERFORMANCE TEST. Performance tests shall be run on the submersible propeller mixing equipment after the installation check is completed, the units are operating properly as determined by the representative of the equipment manufacturer, and after acceptance of the Field System Operation Tests. The performance tests shall be conducted by a capable representative of the manufacturer and accepted by Design-Builder. All costs for these services shall be included in the contract price.

Owner's operating personnel will assist the manufacturer's representative in the performance test. A designated representative of Design-Builder will observe the performance tests.

Preliminary performance tests shall be conducted using the submersible mixer under the design conditions specified. Once the appropriate operation parameters are established, extended duration performance tests shall be conducted to demonstrate the equipment's ability to consistently perform at the design conditions specified.

Performance tests shall be conducted on the mixing equipment in Deox zone and the Anoxic zones. The performance tests shall be performed after the biological processes have reached a mixed liquor suspended solids concentration in the range of 6,000 to 8,000 mg/l for the Anoxic zones and 8,000 mg/L for the Deox zone.

The test results will be used to prove compliance with the performance requirements prior to acceptance of the equipment. Consistent compliance with design conditions shall be defined as the average of sample values meeting or exceeding the specified design conditions.

The equipment manufacturer shall detail the proposed performance testing procedure and analyses, subject to approval by Design-Builder. If more than one day of testing is required, the testing shall be done on consecutive days.

3-3.01. Suspended Solids Distribution Test. In order to evaluate the ability of the mixing equipment to maintain mixed liquor solids in suspension and uniformly distributed throughout the basins, twosuspended solids distribution tests shall be performed.

The suspended solids distribution test shall be performed after the biological processes have reached the operational conditions specified herein. Testing shall be conducted under the biological nutrient removal (BNR) mode of operation of the biological treatment basins. Flows shall be as indicated below. The influent flow will be maintained by adjusting the basin outlet weir.

Basin/Cell	Flow	
Deox	0.97*3	mgd
Anoxic.	0.97*3	mgd

A suspended solids instrument shall be used to measure the suspended solids for the test. Each round of measurements shall consist of one measurement at each of eight points in each test basin/cell as indicated on Fig 1-11515. A minimum of two rounds of measurements shall be taken The measurements shall be averaged and at least 2/3 of the data points shall be within ± 10 percent of the average.

As each sample or measurement is collected the time (month, day, hour and minute) shall be recorded. In the report submitted for review, the collection or measurement times shall be included with the analytical results for each sample or the value of each measurement. The influent flow, RAS flow and MLSS recycle flow shall be recorded at the beginning and end of each round of sampling, and the recorded values shall be included in the report.

For each round of measurements, measurements shall be collected from all eight points in the test basin/cell sequentially or simultaneously. When a round is complete, the subsequent round may begin. Measurements shall be take between 8 a.m. and 5 p.m., but after the influent high flows in the morning stabilize to minimize the chance of changing influent characteristics.

Design-Builder will be responsible for collecting all measurements and ensuring that they are representative. The measurements shall be taken in as short a period as possible, not to exceed 2 hours, to minimize the potential effect of aeration basin influent composition variability.

3-4. TEST REPORTS. The equipment manufacturer shall prepare a formal test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder within 30 days after completion of the specified tests.

3-5. MODIFICATIONS. If the submersible propeller mixing system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be

performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at Submersible Mixer Manufacturer's expense.

3-6. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is directly employed by the manufacturer to instruct Owner's operating personnel in the proper operation and maintenance of the equipment. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-6.01. Operations Training. Classroom instruction covering the theory of operation, site specific operation of the equipment and optimization of the submersible propeller mixer operation.

3-6.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

3-6.03. Maintenance Assistance. Not used.

End of Section

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Section 46 42 24

IN-LINE STATIC MIXERS

PART 1 - GENERAL

1-1. SCOPE. This section covers the supply and installation of the in-line static mixers for the Morro Bay WRF. This specification is to be read in conjunction with the In-Line Static Mixer schedule.

1-2. GENERAL. Equipment provided under this section shall be fabricated in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer.

1-3. SUBMITTALS. Submittals shall include layout drawings of the static mixer for review and approval by the Design-Builder. Submittals will include any and all information on materials of construction, connections, dimensions, accessories provided, and any other information required to verify the mixer meets the specifications and schedule requirements. Submittals shall be submitted in accordance with the Submittals Procedure Section.

PART 2 - PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS. The static mixers shall provide for complete mixing of any and all chemical solutions injected into the static mixer.

Each static mixer shall be designed to achieve and maintain sufficient mixing at all flow rates between maximum and minimum.

2-2. CONSTRUCTION. Each static mixer shall consist of an outer shell and internal mixing elements. Outer shell shall be carbon steel, lined and coated with the manufacturer's recommended coating for waste water microfiltration effluent and compatibility with the chemical injected per the Schedule. Mixing elements shall be of the materials and configuration as recommended by the manufacturer and shall be of sufficient thickness and rigidity to withstand all forces associated with the installation and operating conditions. All mixers shall be rated for a minimum of 100 psi. Mixers shall be designed to be self-supporting between the flanges and will not require independent supports.

Each static mixer shall be supplied with a nameplate permanently fixed to the outside of the mixer body. The nameplate shall contain, at a minimum, the mixer

manufacturer, the mixer name, the mixer tag number, and the materials of construction of the internals.

2-2.01. Ends. Static mixers shall be provided with flat faced, flanged ends, flanges, and drilling shall conform to ANSI/ASME B16.5, Class 150.

2-2.02. Chemical Injection Ports. Static mixer shall be provided with connections upstream of the mixer elements, but on the body of the mixer, to receive the chemicals described in the attached data sheets. Each injection port shall be provided with the accessories described in the Static Mixer Schedule.

PART 3 – EXECUTION

3-1. INSTALLATION. Each unit will be installed by others in accordance the manufacturers instructions.

End of Section

46 42 24 S01 - STATIC MIXERS SCHEDULE

1 RO Feed Tank Effluent Mixer - Liquid Ammonium Sulfate

General Information		
Purpose	Mixing of LAS into RO Feed Flow	
Tag numbers	TBD	
P&I.D. number	33-I-001	
Specification Reference	46 42 24	
Quantity	1	
Equipment Description		
Type	In-line static mixer	
Construction standard	Manufacturer's standard	
Fluid	Treated wastewater through microfiltration effluent	
Fluid flow rate (max)	861	gpm
Fluid flow rate (min)	194	gpm
Diameter	18	inch
Max Length	See drawings	ft
Connection	See drawings	
Chemical Additions		
Added Chemical	Liquid Ammonium Sulfate	
Dispersion element	Injection quill located upstream (by others)	
Wetted material	by others	
Diameter	by others	inch
Connection	by others	
Mixer Construction & Materials		
Body	PVC	
Elements	PVC or FRP	

2 RO Feed Tank Effluent Mixer - Sodium Hypochlorite

General Information		
Purpose	Mixing of NACL into RO Feed Flow	
Tag numbers	TBD	
P&I.D. number	33-I-001	
Specification Reference	46 42 24	
Quantity	1	
Equipment Description		
Type	In-line static mixer	
Construction standard	Manufacturer's standard	
Fluid	Treated wastewater through microfiltration effluent	
Fluid flow rate (max)	861	gpm
Fluid flow rate (min)	194	gpm
Diameter	18	inch
Max Length	See drawings	ft
Connection	See drawings	
Chemical Additions		
Added Chemical	Sodium Hypochlorite (12%)	
Dispersion element	Injection quill located upstream (by others)	
Wetted material	by others	
Diameter	by others	inch
Connection	by others	
Mixer Construction & Materials		
Body	PVC	
Elements	PVC or FRP	

3 RO System Inlet Static Mixer 1

General Information		
Purpose	Mixing of sulfuric acid into RO system flow	
Tag numbers	RO-MXS-001	
P&I.D. number	51-I-001	
Specification Reference	46 42 24	
Quantity	1	
Equipment Description		
Type	In-line static mixer	
Construction standard	Manufacturer's standard	

Fluid	Filtered waste water	
Fluid flow rate (max)	861	gpm
Fluid flow rate (min)	194	gpm
Diameter	12	inch
Max Length	TBD by mfg	ft
Connection	ANSI 150 FF Flange	
Chemical Additions		
Added Chemical	Sulfuric acid (5-10%)	
Dispersion element	Injection quill located upstream (by others)	
Wetted material	by others	
Diameter	by others	inch
Connection	by others	
Mixer Construction & Materials		
Body	PVC	
Elements	PVC or FRP	

4 RO System Inlet Static Mixer 2

General Information		
Purpose	Mixing of antiscalant into RO system flow	
Tag numbers	RO-MXS-002	
P&I.D. number	51-I-001	
Specification Reference	46 42 24	
Quantity	1	
Equipment Description		
Type	In-line static mixer	
Construction standard	Manufacturer's standard	
Fluid	Filtered waste water	
Fluid flow rate (max)	861	gpm
Fluid flow rate (min)	194	gpm
Diameter	12	inch
Max Length	TBD by mfg	ft
Connection	ANSI 150 FF Flange	
Chemical Additions		
Added Chemical	Antiscalant	
Dispersion element	Injection quill located upstream (by others)	
Wetted material	by others	
Diameter	by others	inch
Connection	by others	
Mixer Construction & Materials		
Body	PVC	
Elements	PVC or FRP	

5 UV System Inlet Static Mixer

General Information		
Purpose	Mixing of sulfuric acid into UV system flow	
Tag numbers	UV-MSX-001	
P&I.D. number	52-I-001	
Specification Reference	46 42 24	
Quantity	1	
Equipment Description		
Type	In-line static mixer	
Construction standard	Manufacturer's standard	
Fluid	RO permeate	
Fluid flow rate (max)	645	gpm
Fluid flow rate (min)	175	gpm
Diameter	8	inch
Max Length	TBD by mfg	ft
Connection	ANSI 150 FF Flange	
Chemical Additions		
Added Chemical	Sulfuric acid (5-10%)	
Dispersion element	Injection quill located upstream (by others)	
Wetted material	by others	
Diameter	by others	inch
Connection	by others	

Mixer Construction & Materials

Body	PVC	
Elements	PVC or FRP	

6 UV System Inlet Static Mixer

General Information

Purpose	Mixing of sodium hypochlorite into UV system flow	
Tag numbers	UV-MSX-002	
P&I.D. number	52-I-001	
Specification Reference	46 42 24	
Quantity	1	

Equipment Description

Type	In-line static mixer	
Construction standard	Manufacturer's standard	
Fluid	RO permeate	
Fluid flow rate (max)	645	gpm
Fluid flow rate (min)	175	gpm
Diameter	8	inch
Max Length	TBD by mfg	ft
Connection	ANSI 150 FF Flange	

Chemical Additions

Added Chemical	Sodium hypochlorite (12%)	
Dispersion element	Injection quill located upstream (by others)	
Wetted material	by others	
Diameter	by others	inch
Connection	by others	

Mixer Construction & Materials

Body	PVC	
Elements	PVC or FRP	

Section 46 51 21

COARSE BUBBLE DIFFUSERS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing, installing, and performance testing of coarse bubble diffused aeration equipment for the sludge holding tanks as indicated on the Drawings and as specified herein.

Number of basins. 2

The equipment shall be furnished complete with all concrete foundations as required, baseplates, diffusers, supports, anchor bolts, air piping, air valves, pipe anchors, and any additional materials or construction required by the manufacturer's design.

The diffused aeration equipment manufacturer shall be responsible for supplying all air piping in the basins from the butterfly valve at each drop pipe as indicated on the Drawings, including the drop pipes, manifolds, laterals, and all accessories and appurtenances required for proper installation and operation. Air piping, permanent flow meters, and valves beyond the limits indicated on the Drawings are not required to be provided as part of the diffused aeration equipment manufacturer’s package.

1-2. GENERAL. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, and instructions.

1-2.01. Coordination. All equipment provided in this section shall be furnished by or through a single manufacturer who shall coordinate the design of the diffused aeration system with the requirements of the blower manufacturer.

Air supply to the diffused aeration equipment shall be provided by blowers as specified in the blowers section.

All air supply piping to the basins, including supports and stands, will be as specified in other sections.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-3. SUBMITTALS. Complete fabrication, assembly, foundation, layout, and installation drawings, detailed specifications and data covering material used, parts, and other accessories forming a part of the equipment furnished, together with the diffuser headloss curve, system performance and headloss data, spare parts list, and welder qualifications, shall be submitted in accordance with the Submittals Procedures section.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE DATA AND MANUALS. Not used.

1-5. QUALITY ASSURANCE.

1-5.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. Accurate records of operator and procedure qualifications shall be maintained by Design-Builder and made available to Owner's Representative upon request.

1-5.02. Welder Certification. Not used.

1-5.03. Tolerances. The system shall be designed and manufactured in such a manner that all diffuser elements are within ±0.5 inches [12 mm] of the specified elevation.

1-6. SPARE PARTS. A list of recommended spare parts shall be provided by the Coarse Bubble Diffuser supplier.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All diffused aeration equipment shall be designed to operate satisfactorily under the conditions in the Meteorological and Seismic Design Criteria sections and under the following service conditions.

Type of wastewater treatment prior to aeration.	Degritted, Screened Waste Activated Sludge (WAS)
Type of basin for aeration use.	Sludge holding/mixing
Number of air supply blowers.	2

Air temperature range at top of drop pipe.	100 to 275	F

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at the specified elevation.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Aeration units shall be designed for the following operating conditions:

Number of aeration basins (parallel trains)	2	
Basin dimensions (for rectangular basin, length x width)	38’-10” x 38’-10”	ft
Sidewater depth (varying)*	8 to 20	ft
Total volume per basin	31,480	ft^3
Number of aerated zones per basin	1	
Design mixed liquor temperature		
Winter (minimum)	17	°F
Summer (maximum)	22	°F
Annual average	19	°F

*Aeration cycles on and off so diffusers will not always be in operation; however, they shall be able to operate at the water depths specified.

Condition	Minimum	Average	Maximum	
Sludge flow	29,000	29,000	38,500	gpd
TSS concentration	6,600	9,350	7,700	mg/L
VSS/TSS	0.65	0.65	0.65	--
Filtered BOD concentration	< 5	< 5	< 5	mg/L
NH_4-N concentration	<1	<1	<1	mg/L

Condition	Minimum	Average	Maximum	
Oxygen uptake rate	10	15	17	mg/L/hr
Liquid temperature	17	19	22	°F
Side Water Depth	20	16	8	ft
Minimum basin oxygen concentration, C min	0.5	1.5	0.1	mg/L
Alpha factor	0.85	0.85	0.85	--
Beta factor	0.9	0.9	0.9	--
KLa, 20ºC	1.4	2.3	2.3	hr^{-1}
Standard oxygen transfer rate (SOTR)*	25	36	17	pph
Airflow rate/basin	195	310	320	SCFM
Maximum allowable pressure drop through submerged piping and diffuser from top of drop pipe			0.6	psi
Minimum number of diffusers/basin	30	30	30	
Minimum number of diffuser grids/basin	1	1	1	

* Standard condition is at 20°C and 1 atm clean water.

Airflow will be stopped intermittently and a submersible mixer will be employed for mixing. In addition, mixing and airflow may be used simultaneously if the basin is mixing-limited with aeration only.

2-2.01. Design and Performance Criteria. The aeration equipment shall convey air from the air mains to the air diffusers. The air distribution lines shall be designed and installed so that adding air to the lines will expel all water or waste therefrom. The air diffusers shall diffuse the air uniformly into the basins in which they are submerged.

The aeration system shall be designed to transfer the required amount of oxygen and shall have sufficient mixing capacity to thoroughly mix the entire contents and to keep all solids in suspension.

The diffused aeration equipment shall be designed to meet the design criteria and performance requirements specified herein. The capability of the aeration equipment to meet the oxygen transfer rates specified shall be determined by shop or field performance tests specified herein.

2-2.02. Supplemental Mixing. A supplemental mixing system will be installed in the sludge holding tanks along with the diffused coarse bubble aeration system. The mixer manufacturer will set the elevation of the mixer so as not to interfere with the aeration diffuser grid piping, and will recommend the area under the mixer where diffusers are not to be installed to prevent diffuser damage from mixer pumping action and air bubbles from causing mixer impeller cavitation. The recommended area shall have diffuser grid headers installed without diffuser assemblies.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers of coarse bubble diffused aeration units are Environmental Dynamics, Inc., Sanitaire, or equal.

2-4. MATERIALS.

Diffuser Assembly	AISI 316L stainless steel equivalent to Schedule 80 pipe with an end cap of cast equivalent of AISI 304L stainless steel with a 3/4 inch NPT male pipe thread connection.
Drop Pipes	Stainless steel ASTM A312 or ASTM A778 with longitudinal seams, Grade TP304L, Schedule 10S.
Air Distribution Manifold	Stainless steel ASTM 240, Type 304L, Schedule 10S.
Flanges	Sized to match the diameter and drilling of the ANSI B16.5, 150 psi standard for steel flanges.
Diffuser Header Laterals	Stainless steel ASTM 240, Type 304L, Schedule 10S.
Supports, Clamps, and Anchors	ASTM A240, Type 304L stainless steel.
Bolts, Nuts, and Washers	AISI Type 304, Bolts ASTM F593, Alloy Group 1; Nuts ASTM F594, Alloy Group 1; Washers ANSI B18.22.1. Minimum diameter of anchor bolts shall be ½" for air distribution manifolds and 3/8" for diffuser header laterals.

Flange Bolts	ASTM A193 Class 2, AISI Type 304, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut.
Flange Nuts	ASTM A194, AISI Type 304, ANSI/ASME B18.2.2, heavy hex pattern.
Welded Parts and Assemblies	Sheets and plates of ASTM A240, Type 304L.
Nonwelded Metals	Sheets and plates of stainless steel ASTM A240, Type 304.
Gaskets	45-55 durometer (Shore A) neoprene.
Tubular Products and Fittings	Grade TP304L, fabricated in conformance with ASTM A774 and ASTM A778.

Contact between dissimilar metals is not acceptable.

2-5. CONSTRUCTION.

2-5.01. Diffused Aeration Equipment. The diffused aeration equipment shall consist of drop pipes, air piping, diffuser assemblies, pipe supports, and all accessories indicated on the Drawings, specified or required for proper installation and functioning of the diffused air system.

2-5.02. Diffusers. Air shall be released uniformly along a minimum air band of 2 feet beyond the air header. Air exiting the diffuser shall clear the air header.

Diffuser assemblies shall be wide band or Sparger type.

Each diffuser shall consist of one inverted air reservoir of the size as recommended by the manufacturer, deflector, air exit ports, and balancing nozzle. The balancing nozzle shall provide the proper head loss to assure uniform air distribution throughout the aeration system. The exit ports shall be located on each side of the diffuser in horizontal planes on two levels to discharge air into the liquid. The deflector shall be located below the open bottom of the inverted air reservoir, shall direct the liquid being aerated along the inverted air reservoir's outer walls, shall prevent rags or other material from entering the diffuser, and shall be supported by connection directly to the diffuser. The air exiting the ports shall be sheared into small bubbles and shall be well distributed into the liquid.

Connections of the diffuser to the header shall require only one fitting. A combination of tees, elbows and nipples will not be an acceptable method of connection.

2-5.03. Diffused Aeration Piping. A diffused aeration piping system shall be furnished to distribute air from the aeration air supply piping to the diffusers. The piping system shall begin at the drop legs as indicated on the Drawings. The piping system shall include the entire air distribution system, including all drop pipes, air distribution manifolds and diffuser header laterals. The piping shall be provided complete with all fittings, specials, flanges, couplings, slip joints, anchors, gaskets, bolts and nuts, pipe supports, end caps, connections, appurtenances, and accessories which are indicated on the Drawings or are required for proper installation and functioning of the diffused aeration system.

The diffused aeration drop pipes shall be in the locations as indicated on the Drawings. The minimum size of drop pipes shall be as recommended by the manufacturer, but in no case smaller than the minimum diameter specified herein. The diffused aeration system manufacturer shall provide a reducer with a flanged connection if required for connection of the drop pipe to the piping furnished by the Design-Builder.

All air distribution manifolds and diffuser header laterals shall be stainless steel and shall be sized by the manufacturer to evenly distribute the flow to all diffusers with a minimum pressure drop. The size of the piping shall be as recommended by the manufacturer. Flanged or union type joints shall connect the distribution header to the diffuser lateral. All piping shall be supported with stainless steel pipe stands.

All subsurface connections, yokes, baseplates, supports and fasteners, shall be free from protrusions, sharp angles, and excessively long bolts to which rags or stringy materials may become attached.

Each air distribution header shall be fabricated in section lengths as recommended by the manufacturer. The bottom elevation of each air distribution header shall be the same throughout the basin. Changes in diameter shall be accomplished by using eccentric reducers. Air headers shall be designed and installed so that adding air to the lines will expel all water and waste from the lines. The end of each header shall have welded end caps. Connections between sections of the air distribution headers shall be designed so that individual header sections can be rotated independently of adjacent header sections for alignment purposes.

Each air distribution header shall include an expansion-contraction system consisting of expansion joints, fixed supports and flanged header connections. Fixed supports shall be designed to anchor the header against longitudinal movement at the support. Intermediate supports between fixed supports and

expansion joints shall allow for longitudinal movement. The entire system shall be designed to allow for expansion and contraction over the specified air temperature range at the top of the drop pipe without air leakage.

The diffuser connectors shall be factory welded to the bottom (on center line) of the air distribution header. The connectors shall be of such length and so positioned to allow air exiting the diffuser to clear the air header. All connectors shall be installed on a common horizontal plane. Diffuser connectors and piping shall be of adequate strength to withstand a vertical load applied at the threaded end of the connector which results in a bending moment of 1,000 in-lbs at the diffuser connector without any permanent deformation. All diffuser connectors shall have provisions for placement of two diffusers to allow for future expansion.

2-5.04. Pipe Supports. Pipe supports shall be fabricated as specified herein and shall be provided complete with all bases, anchor bolts and nuts, plates, rods, and other accessories required for proper installation.

Pipe supports shall be fabricated from stainless steel components in conformance with the material and fabrication requirements specified in the section pertaining to diffused aeration piping.

Pipe supports shall be the manufacturer's standard support system and shall be comprised of fixed and simple floor supports as required by the piping configuration. Pipe supports shall be constructed of angle members welded together forming a frame and bolted to the floor with expansion anchors. A clamp around the header or manifold piping shall be bolted to the support.

Each horizontal and vertical portion of the air distribution section headers shall have a minimum of two supports. Supports shall be spaced as recommended by the manufacturer. All supports shall include a mechanism to provide for a minimum of ±2 inches (vertical and ±1/2 inch lateral adjustment for alignment of the piping.

One support for each section of piping shall include an integral device for rotational adjustment during installation. All adjusting devices and mechanisms shall have provisions to be locked in place to secure the piping in position after final adjustment and alignment.

2-5.05. Bolts and Nuts. Assembly bolts and nuts shall be provided as required for each aeration system. Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2-6. FABRICATION

2-6.01. Welding. All welding shall be completed in the factory using the shielded arc, inert gas, MIG or TIG method. Field welding will not be allowed. Filler wire

shall be added to all welds to provide for a cross section and weld metal equal to or greater than the parent metal. Butt welds shall have full penetration to the interior surface and gas shielding shall be provided to the interior and exterior of the joint. Interior weld beads shall be smooth, evenly distributed with an interior projection not exceeding 1/16 inch beyond the inside diameter of the air header or fitting. Face rings and flanges shall be continuously welded to pipe and fittings. Stitch welds will not be acceptable.

2-6.02. Surface Preparation. Unless otherwise specified or permitted, all items fabricated from stainless steel shall be thoroughly cleaned, degreased, and pickled following fabrication as specified in ASTM A380. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. Pickled surfaces shall be subjected to a 24 hour water test or ferroxyl test to detect the presence of residual embedded iron and shall be repickled as needed to remove all traces of iron contamination. Pickled surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces. Blast cleaning of stainless steel will not be acceptable.

2-7. SPECIAL TOOLS AND ACCESSORIES. The manufacturer shall furnish all special tools required for the assembly, disassembly, adjustment, and maintenance of all components of the diffused aeration equipment. One set of special tools shall be provided.

PART 3 - EXECUTION

3-1. INSTALLATION. The diffused aeration system shall be installed in the locations as indicated on the Drawings, in accordance with the Equipment Installation section and as specified herein.

Diffusers shall be installed as shown on the Drawings, and shall be level with a maximum allowable variance of 0.25 inch per foot of diffuser length. Deforming of air header, diffuser connectors, diffusers, or pipe supports to align or level the system will not be allowed. The connection of the drop pipe to the air distribution header shall be made using a flexible joint to allow ease of installation and alignment. Field connections in the diffused aeration system shall be flanged, threaded, mechanically coupled, or grooved end couplings. Field welding of the diffused aeration equipment will not be allowed.

All diffusers shall be attached to the diffused aeration piping using stainless steel welding connectors as recommended by the manufacturer.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect,

check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Start-up Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. PERFORMANCE TESTS. Prior to equipment acceptance, field performance tests shall be conducted on the diffused aeration equipment in the sludge holding tanks to demonstrate that the equipment meets specified oxygen transfer and airflow rate requirements.

Personnel in charge of the tests shall be competent, authorized representatives of the equipment manufacturer who are familiar with operation of the equipment furnished and who have previous satisfactory experience in conducting tests of the type specified. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results.

The equipment manufacturer shall provide support facilities which shall include, but not be limited to, power, equipment, chemical storage tanks, mixing equipment, chemicals for dissolved oxygen determinations by the modified Winkler method, chemicals for K_La determination by the nonsteady state sulfite method, DO probes, scales, and such other equipment and facilities as may be necessary.

Dissolved oxygen concentration measurements shall be made with direct reading instruments which have been standardized against a laboratory determination of dissolved oxygen as described in the latest edition of "Standard Methods for Examination of Water and Waste Water," with appropriate modification for interfering substances. One direct reading instrument shall be provided for each point shown on Figure 2-46 51 31. Each instrument shall have a probe cord of adequate length.

3-3.01. Test Procedures. The performance tests shall be performed in accordance with the requirements specified herein, in water from a potable water source, and a water temperature between 59°F and 77°F.

A minimum of three tests shall be conducted at the maximum airflow conditions. One test shall be conducted at the minimum airflow condition, and one additional test at an airflow rate approximately midway between the minimum and maximum conditions shall be performed to plot the specified performance curves. The tests at the maximum airflow conditions shall be conducted first. No pre-conditioning tests are allowed.

The data to be determined in each test shall include, but not be limited to:

Airflow rate in scfm.

Air supply temperature and pressure.

Continual recording of centrifugal blower power.

Rate of change of the dissolved oxygen concentration preceding, during, and following DO depletion.

Liquid temperature.

Uncorrected barometric pressure.

Pressure at top of drop pipe.

Additional data as necessary to determine compliance with the specifications.

Before each test, the aeration system should be operated for a period of time at the test airflow rate to achieve steady state conditions.

In each test, sodium sulfite solution shall be added to the water to deplete the oxygen concentration to zero. A 10 percent, by weight, solution of sodium sulfite (Na_2SO_3) shall be prepared in sufficient quantity to deplete and maintain the zero condition for one minute on all probe readouts simultaneously.

Stoichiometrically, about 75 lbs of 96 percent pure sodium sulfite will be required per million gallons to deplete the oxygen concentration one milligram per liter. A minimum of 150 percent of the stoichiometric concentration is typically required to achieve and maintain zero conditions for one minute. Technical grade sodium sulfite, free of catalyst, shall be used.

Data shall be recorded that shows oxygen depletion. The data shall also show that all test points remained at zero dissolved oxygen for at least one minute simultaneously. The test shall be considered invalid if zero dissolved oxygen is not reached for at least one minute at all test points simultaneously.

A 10 percent, by weight, solution of cobalt chloride ($CoCl_2$ $6H_2O$) shall also be prepared for the initial series of tests. About 34 lbs of cobalt chloride will be required per million gallons to obtain a cobalt ion concentration of one milligram per liter. For test purposes, the cobalt ion concentration shall be 0.5 mg/L or less.

For the initial series, the cobalt chloride solution shall be introduced into the tank with the diffused aeration system operating. After a minimum of 15 minutes of operation, addition of the sodium sulfite solution shall be started slowly. It will not be acceptable to turn down the air to achieve better deoxygenation with sodium sulfite. The entire quantity of sodium sulfite solution shall be added to the tank within a period of approximately 5 minutes in a manner achieving uniform dispersion throughout the tank.

After the first tests have been completed, another batch of sodium sulfite shall be prepared and the procedure repeated. No additional cobalt chloride solution should be required after the first series. Should additional chemicals be required, they shall be provided at no additional cost to Owner. No more than ten tests shall be made with the same test water.

The equipment shall be operated to reaerate the water until oxygen saturation is reached. Dissolved oxygen concentrations shall be monitored continuously and recorded during the depletion and the reaeration periods. Dissolved oxygen concentrations shall be recorded at equal increments of approximately one minute, or at a time interval which provides at least 15 readings between 10 and 90 percent of the measured DO saturation value. DO-time data shall be recorded during DO depletion and over the full aeration time. The temperature of the test liquid shall be recorded before and after each test run. Cobalt ion concentration of the test water will be measured after completion of tests by an independent testing laboratory and the test paid for by Owner. Points of dissolved oxygen measurements shall be as shown on Figure 2-11572.

3-3.02. Flow Meters. Flow meters are not provided for the sludge holding tank blowers.

3-3.03. Data Analysis. The dissolved oxygen deficit from saturation (C_s-C_t) for each measurement point shall be calculated and plotted on semilog paper versus time (t) where C_t is the measured oxygen concentration at any time (t), and C_s is the average dissolved oxygen concentration, at temperature T, attained by aerating the basin contents until no further increase in dissolved oxygen concentration is detected.

A line of best fit shall be drawn utilizing regression analysis on all points. A sample of such a plot is provided for reference only on Figure 1-46 51 31.

The overall oxygen transfer coefficient $(K_La)_T$ for each point of measurement specified shall be computed by determining the slope of the line of the best fit by using the following equation:

$$(K_La)_T = \frac{\ln [(C_s-C_1) / (C_s-C_2)]}{t_2-t_1} \quad (hr^{-1})$$

where:

T	=	water temperature, centigrade
C_s-C_1	=	initial (t_1) dissolved oxygen deficit, (mg/L)
C_s-C_2	=	final (t_2) dissolved oxygen deficit, (mg/L)
t_2-t_1	=	time span, (hr)
C_s	=	average of all dissolved oxygen concentrations, liquid temperature T, attained at each test location by aerating the basin contents until no further increase in oxygen concentration is detected, (mg/L)

The oxygen transfer rate constant for each measurement point shall be corrected to 20 C by the following formula:

$$(K_La)_{20} = (K_La)_T(\mu_T/\mu_{20})^{1.065}(hr^{-1})$$

where:

μ	=	absolute viscosity, (lb-sec/ft^2)

The individual values of $(K_La)_{20}$ from each test location for all three tests at maximum airflow shall be averaged and at least two-thirds of the individual $(K_La)_{20}$ values shall be within 10 percent of the average value. If not, additional tests shall be conducted until two-thirds of the $(K_La)_{20}$ values are within 10 percent of the average of all $(K_La)_{20}$ values.

The standard oxygen transfer rate by the aeration system shall be calculated by using the average value of $(K_La)_{20}$ in the following equation:

Standard Oxygen Transfer Rate	=	$8.34\ (K_La)_{20}\ V_B\ C_s(std)$ (lb/hr)

where:

V_B	=	aeration basin volume tested in million gallons
$C_s(std)$	=	the measured C_s value during the performance testing corrected to standard conditions (20 C and sea level) and shall be determined by
$C_s(std)$	=	$[C_s] \times [9.09/C_s(a)]^{0.913}$

where:

$C_s(a)$	=	theoretical surface oxygen saturation value at test site barometric pressure and liquid temperature T, (mg/L)
C_s	=	measured oxygen saturation value at test site conditions, (mg/L)

The standard oxygen transfer rates, as determined by the performance tests, shall not be less than the values specified herein. The airflow rates used in the performance tests to meet the specified peak standard oxygen transfer rate values shall not exceed the values specified herein.

3-3.04. Test Performance Curve. The equipment manufacturer shall furnish a performance curve showing the relationship between oxygen transfer in pounds of oxygen per hour as a function of airflow in scfm over the full operating range of the equipment.

3-4. TEST REPORTS. The equipment manufacturer shall prepare a test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder after completion of the specified tests.

3-5. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer's expense.

3-6. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-6.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-6.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 46 51 31

FINE PORE DIFFUSED AERATION EQUIPMENT

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing and performance testing of fine pore diffused aeration equipment for the basins as indicated on the Drawings and as specified herein.

Aeration basin tags.	Aerobic Grid 1: 1101, 2101
	Aerobic Grid 2: 1201, 2201
Number of basins.	2, 2 aeration zones in each

The equipment shall be furnished complete with all aeration diffusers, supports, anchor bolts, air piping, pipe anchors, portable pressure monitoring control panels and pressure monitoring equipment, and any additional materials or construction specified or otherwise required for proper operation.

The diffused aeration equipment manufacturer shall be responsible for supplying all air piping in the aeration basins from the butterfly valve at each drop pipe as indicated on the Drawings, including the drop pipes, manifolds, laterals, pressure monitoring equipment, and all accessories and appurtenances required for proper installation and operation. Air piping, permanent flowmeters, and valves beyond the limits indicated on the Drawings are not required to be provided as part of the diffused aeration equipment manufacturer package.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. Coordination. All equipment provided in this section shall be furnished by or through a single manufacturer who shall coordinate the design of the diffused aeration system with the requirements of the blower manufacturer and shall be referred to as the Process Air Blower System Supplier (PABSS).

Air supply to the diffused aeration equipment will be from blowers that are specified in the applicable blower section.

All air supply piping to the basins, including supports and stands, will be as specified in other sections.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.03. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-3. SUBMITTALS. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section.

Additionally, the manufacturer shall submit a letter sealed and signed by a professional engineer registered in the state where the Project is located, certifying that under all specified operating conditions:

> The design provides sufficient cooling in the stainless steel portion of the pipe in each drop leg, so the temperature of the mean wall (midpoint of wall thickness) at any point in the PVC or CPVC pipe to be installed, is below the rated continuous operating temperature of the pipe, and
>
> The design provides sufficient cooling to reduce the process air temperature to the rated continuous operating temperature of the PVC diffuser components.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. OPERATION AND MAINTENANCE DATA AND MANUALS. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-5. QUALITY ASSURANCE.

1-5.01. Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be in written form and subject to Design-Builder's review. Accurate records of operator and procedure qualifications shall be maintained by Design-Builder.

1-5.02. Welder Certification. Not used.

1-5.03. Tolerances. The system shall be designed and manufactured in such a manner that all diffuser elements are within ± 0.5 inches of the elevation indicated herein.

1-6. WARRANTY. The Warranty shall be as indicated in the General Terms and Conditions.

1-7. SPARE PARTS. The PABSS shall provide a list of recommended spare parts.

Spare parts shall be packaged in accordance with the general Terms and Conditions with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Spare parts shall be delivered to Owner as directed.

Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. All diffused aeration equipment shall be designed to operate satisfactorily under the conditions in the Meteorological and Seismic Design Criteria section and under the following service conditions:

Type of wastewater treatment prior to aeration.	Degritted, Screened	
Type of basin for aeration use.	Activated sludge	
Number of air supply blowers.	3	
Air Temperature range at top of drop pipe.	100 to 275	F

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at the specified elevation.

2-2. PERFORMANCE AND DESIGN REQUIREMENTS. Aeration units shall be membrane disc type without PTFE coating designed for the following operating conditions:

Number of aeration basins (parallel trains).	2	
Aerobic Basin dimensions (for rectangular basin, length x width).	57’-6” x 23’-3”	ft
Typical Sidewater depth.	18	ft
Maintenance Condition Sidewater Depth.	19.5	Ft
Total volume per train.	28,100	ft^3
Oxic volume per train.	24,060	ft^3
Number of aerated zones per train.	2	
Design mixed liquor temperature.		
Winter (minimum).	17	F
Summer (maximum).	22	F
Annual average.	19	F
Range of sludge recirculation (percent of annual average design flow)	300 to 500	

Condition	Peak Day	Maximum Month	Annual Average	Start-Up Minimum Month	Start-Up Minimum Day	
Plant flow.	1.88	1.16	0.97	0.74	0.59	mgd
BOD concentration to aeration basin.	310	375	355	330	320	mg/L
BOD load to aeration basin.	4,845	3,628	2,872	2,037	1,575	ppd
TKN concentration to aeration basin.	49.5	68	57	53	51	mg/L
TKN load to aeration basin.	777	658	461	327	250	ppd

	Peak Day Summer	Maximum Month Summer	Annual Average, Average	Start-Up Minimum Month Winter	Start-Up Minimum Day Winter	
Zone 1/Basin						
Oxygen uptake rate.	103	90	70	52	48	mg/L/hr
Liquid temperature.	22	22	19	17	17	F
Typical oxygen concentration, C min.	1.2	2.0	2.0	2.0	2.0	mg/L
Alpha factor.	0.55	0.55	0.55	0.55	0.55	--
Beta factor.	0.9	0.9	0.9	0.9	0.9	--
KLa, 20ºC.	22.8	22.3	16.7	12.2	11.2	hr^{-1}
Standard oxygen transfer rate (SOTR)*	182	178	133	97	90	pph
Airflow rate.	612	596	426	297	271	scfm
Maximum initial pressure loss through system including water submergence, from top of drop pipe at maximum month airflow.	8.4	8.4	8.4	8.4	8.4	psi
Minimum number of diffusers.	220	220	220	220	220	--
Minimum number of diffuser grids.	1	1	1	1	1	--
Zone 2/Basin						
Oxygen uptake rate.	62	52	40	29	26	mg/L/hr

	Peak Day Summer	Maximum Month Summer	Annual Average, Average	Start-Up Minimum Month Winter	Start-Up Minimum Day Winter	
Liquid temperature.	22	22	19	17	17	F
Typical oxygen concentration, C min.	1.2	2.0	2.0	2.0	2.0	mg/L
Alpha factor.	0.6	0.6	0.6	0.6	0.6	--
Beta factor.	0.9	0.9	0.9	0.9	0.9	--
KLa, 20ºC.	12.7	11.7	8.8	6.3	5.6	hr^{-1}
Standard oxygen transfer rate (SOTR)*	101	93	70	50	45	pph
Airflow rate.	332	302	217	147	130	scfm
Maximum initial pressure loss through system including water submergence, from top of drop pipe at maximum month airflow	8.4	8.4	8.4	8.4	8.4	psi
Minimum number of diffusers.	160	160	160	160	160	--
Minimum number of diffuser grids.	1	1	1	1	1	--

*Standard conditions are 20°C and 1 atm clean water.

2-2.01. Design and Performance Criteria. The aeration equipment shall convey air from the air mains to the air diffusers. The air distribution lines shall be designed so that adding air to the lines will expel all water or waste. The air diffusers shall diffuse the air uniformly into the basins in which they are submerged.

The aeration system shall be designed to transfer the required amount of oxygen and shall have sufficient mixing capacity to thoroughly mix the entire contents and to keep all solids in suspension.

The diffused aeration equipment shall be designed to meet the performance and design requirements specified herein. The capability of the aeration equipment to meet the specified oxygen transfer rates shall be determined by shop performance tests specified herein.

2-2.02. Supplemental Mixing. No supplemental mechanical mixing will be provided in any zone.

2-3. ACCEPTABLE MANUFACTURERS. Acceptable manufacturers of fine pore diffused aeration units are Environmental Dynamics, Sanitaire, or equal if approved.

2-4. MATERIALS.

Drop Pipes and Air Distribution Piping Where Required for Heat Dissipation	Stainless steel, ASTM A312 Grade TP 304L and AISI Type 304L, Schedule 10S.
Air Distribution Manifolds	ASTM D1785 Cell Classification 12454 Schedule 40 PVC, ultraviolet resistant or ASTM F441 Cell Classification 23447 Schedule 40 CPVC ultraviolet resistant.
Diffuser Header Laterals	
Discs	ASTM D3034 and D3915 SDR min. 35 PVC, ultraviolet resistant or, ASTM D1784, ASTM D1785 Cell Classification 12454, Schedule 40 PVC, ultraviolet resistant.
Fittings	ASTM D2466 Cell Classification 12454 Schedule 40 PVC, ultraviolet resistant or ASTM F438 Cell Classification 23447 Schedule 40 CPVC ultraviolet resistant.
Joints and End Caps	Ultraviolet-resistant PVC, compression type with neoprene seals; thickness class to be the same as the pipe.
Supports, Clamps, and Anchors	ASTM A240 and A276, Type 304 L stainless steel.
Bolts, nuts, and washers	AISI Type 304, Bolts ASTM F593, Alloy Group 1; Nuts ASTM F594, Alloy Group 1; Washers ANSI B18.22.1. Minimum diameter of anchor bolts shall be 1/2” for air distribution manifolds and 3/8” for diffuser header laterals.

Flange Bolts	ASTM A193 Class 2, AISI Type 304, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut
Flange Nuts	ASTM A194, AISI Type 304, ANSI/ASME B18.2.2, heavy hex pattern.
Diffuser Assembly	
Membrane Disc	EPDM membrane disc with an ultraviolet inhibitor; ultraviolet-resistant PVC or polypropylene holder.
Moisture Blowoff Assembly	ASTM D1784 and ASTM D2241, Type 1, Grade 1, Schedule 80 PVC piping and fittings, solvent welded, with PVC ball valves, ultraviolet resistant.
Welded Miscellaneous Metals	ASTM A240, Type 304L stainless steel.
Nonwelded Miscellaneous Metals	ASTM A240, Type 304.
Gaskets	Neoprene, 45 to 55 Type A durometer, tested in accordance with ASTM D2240.
Tubular Products and Fittings	Grade TP304L, fabricated in conformance with ASTM A778 and ASTM A774.

Contact of dissimilar metals is not acceptable.

2-5. CONSTRUCTION.

2-5.01. Diffused Aeration Equipment. The diffused aeration equipment shall consist of drop pipes, air piping, diffuser assemblies, pipe supports, moisture blowoff assemblies, and all accessories indicated on the Drawings, specified, or required for proper installation and functioning of the diffused air system.

2-5.02. Ceramic Disc Diffuser Assemblies. Not used.

2-5.03. Membrane Disc Diffuser Assemblies. Each disc diffuser assembly shall consist of a round, flexible membrane diffuser element, a disc membrane holder with integral backflow prevention mechanism, and an independent retaining system to attach the membrane to the holder. The material used for both the membrane diffuser element and the membrane holder shall be noncorrosive and UV resistant.

The membrane diffuser element shall be an EPDM material with an ultraviolet inhibitor and compounds designed for resistance to chemical attack, weathering, and aging. Data shall be provided to show the chemical resistivity of the membrane material proposed for installation. The surface of the membrane must be smooth to prevent biological growth from attaching.

The diffuser assembly shall be connected to the air distribution piping using a connection saddle or casting. Direct connection of the diffuser assembly to the air distribution piping shall not be acceptable. The connection saddle or casting shall be one piece construction, high strength PVC, polypropylene or other suitable material, and must be either threaded or provided with an alternative mechanism for mounting of diffuser assemblies.

Connection saddles or castings that are solvent welded to the crown of the air distribution piping shall be attached in the factory. Field installation of connection saddles or castings shall not be acceptable. For connection saddles that consist of an independent saddle/wedge assembly, installation may be completed in the field.

2-5.04. Tube Diffuser Assemblies. Not used.

2-5.05. Diffused Aeration Piping. A diffused aeration piping system shall be provided to distribute air from the aeration supply piping to the diffusers. The piping system shall begin after the butterfly valve as indicated on the Drawings. The piping system shall include the entire air distribution system, including all drop pipes, air distribution manifolds and diffuser header laterals. The piping shall be provided complete with all fittings, specials, flanges, couplings, slip joints, anchors, gaskets, bolts and nuts, pipe supports, end caps, connections, appurtenances, and accessories indicated on the Drawings, as required, or needed for proper installation and functioning of the diffused aeration system.

The diffused aeration drop pipes shall be in the locations as indicated on the Drawings. The minimum size of drop pipes shall be as recommended by the manufacturer but in no case smaller than the minimum diameter specified herein. The diffused aeration system manufacturer shall provide a reducer with a flanged connection if required for connection of the drop pipe to the piping furnished by the Design-Builder.

If sufficient cooling of the process air can be achieved in the drop pipe, the air distribution manifolds and the diffuser header laterals shall be ultraviolet-resistant PVC, and shall be sized by the manufacturer to evenly distribute the flow to all diffusers with a minimum pressure drop. If cooling of the air to the maximum operating temperature of the PVC pipe under all specified conditions cannot be achieved in the drop pipe, stainless steel shall be extended into the manifold and laterals in sufficient length to achieve the required cooling, and PVC pipe shall be installed for the remainder of the air distribution system. Alternatively, ultraviolet-

resistant CPVC pipe may be used. The manufacturer shall engage a professional engineer registered in the state where the Project is located, to certify that under all specified operating conditions

The design provides sufficient cooling in the stainless steel portion of the pipe in each drop leg, so the temperature of the mean wall (midpoint of wall thickness) at any point in the PVC or CPVC pipe to be installed, is below the rated continuous operating temperature of the pipe, and

The design provides sufficient cooling to reduce the air temperature to the rated continuous operating temperature of PVC diffuser components.

A stainless steel band coupling shall connect stainless steel pipe to PVC or CPVC pipe. Flanged or union type joints shall connect the manifold to the PVC diffuser headers. All piping shall be supported with stainless steel pipe stands.

All subsurface connections, including supports and fasteners, shall be free from protrusions and sharp angles to which rags or stringy materials may become attached.

Each air distribution header shall be fabricated in sections having a maximum length as recommended by the manufacturer. Changes in diffuser header diameter shall not be acceptable. Connections between sections of the air distribution headers shall be designed so that individual header sections can be rotated independently of adjacent header sections for alignment purposes.

Each air distribution header shall include an expansion-contraction system consisting of expansion joints, fixed supports, and flanged header connections. Fixed supports shall be designed to anchor the header against longitudinal movement at the support. Intermediate supports between fixed supports and expansion joints shall allow for longitudinal movement. The entire system shall be designed to allow for expansion and contraction over the specified air temperature range at the top of the drop pipe, without air leakage.

All pipe diameter transitions between header pipe and laterals shall be made using eccentric tees such that the pipe inverts remain the same throughout the horizontal grid system.

2-5.06. Field Connections and Expansion Provisions. All field connections shall be flanged or made with a threaded union or as determined by the Design-Builder. Expansion joints or loops shall be furnished, to allow for expansion and contraction of the diffused aeration piping. For a system with fixed joints, the joints shall be located between supports where the piping is longitudinally fixed. The joints shall provide for full movement of the piping over the specified temperature range, without air leakage.

2-5.07. Pipe Supports. Pipe supports shall be fabricated as specified herein and shall be provided complete with all bases, anchor bolts and nuts, plates, rods, and other accessories required for proper installation. Support anchors shall be 3/8 inch diameter minimum and shall be suitable to resist all loads, including vibratory loads.

One support for each section of piping shall include an integral device for rotational adjustment during installation. All adjusting devices and mechanisms shall have provisions to be locked in place to secure the piping in position after final adjustment and alignment. Clamps used to fasten manifold and lateral piping to pipe supports shall have a minimum width of 1-1/2 inch.

All supports shall include a mechanism to provide for a minimum of ± 2 inches vertical and ± 1/2 inch lateral adjustment for alignment of the piping. The spacing between supports shall be as recommended by the manufacturer. For grids located on sloped tank bottoms, additional adjustment shall be provided.

2-5.08. Moisture Blowoff Assemblies. A moisture blowoff assembly shall be provided for each grid to drain the entire submerged aeration piping. All components of the piping shall be supported along the aeration basin wall. The size of purge piping and valves shall be as recommended by the manufacturer. The assembly shall include a sump or drop pipe for the collection of moisture, purge piping extending to near the top of the basin wall, and a blowoff valve. Blowoff valves shall be ball valves as specified in the Miscellaneous Ball Valves section.

2-5.09. Cleanouts. A cleanout with a threaded or other easily removable end cap shall be provided at the ends of each diffuser lateral.

2-5.10. Bolts and Nuts. Assembly bolts and nuts shall be provided as required for each aeration system. Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2-6. FABRICATION.

2-6.01. Welding. All welding shall be completed in the factory using the shielded arc, inert gas, MIG or TIG method. Field welding will not be allowed. Filler wire shall be added to all welds to provide for a cross section and weld metal equal to or greater than the parent metal. Butt welds shall have full penetration to the interior surface and gas shielding shall be provided to the interior and exterior of the joint. Interior weld beads shall be smooth, evenly distributed with an interior projection not exceeding 1/16 inch beyond the inside diameter of the air header or fittings. Face rings and flanges shall be continuously welded to pipe and fittings. Stitch welds will not be acceptable.

2-6.02. Surface Preparation. Unless otherwise specified or permitted, all items fabricated from stainless steel shall be thoroughly cleaned, degreased, and pickled following fabrication as specified in ASTM A380. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. Pickled surfaces shall be subjected to a 24 hour water test or ferroxyl test to detect the presence of residual embedded iron and shall be repickled as needed to remove all traces of iron contamination. Pickled surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces. Blast cleaning of stainless steel will not be acceptable.

2-7. ACCESSORIES.

2-7.01. Special Tools and Accessories. The manufacturer shall furnish all special tools, instruments, and accessories required for the assembly, disassembly, adjustment, and maintenance of all components of the diffused aeration equipment. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2-7.02. Portable Pressure Monitoring Control Panel. Not used.

PART 3 - EXECUTION

3-1. INSTALLATION. Installation shall be in accordance with the Equipment Installation section and as specified herein.

Diffusers shall be leveled to within plus or minus 1/8 inch of a common horizontal plane. Deforming of air headers, diffuser connectors, diffusers, or pipe supports to align or level the system will not be allowed.

All diffusers shall be connected directly to the diffused aeration piping as recommended by the manufacturer.

The connection of the drop pipe to the air distributor header shall be made using a flexible joint to allow ease of installation and alignment. Field connections in the diffused aeration system shall be flanged, threaded or as determined by the Design-Builder. Field welding of the diffused aeration equipment will not be allowed.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Start-up Requirements section and shall revisit the job site

as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

3-3. SHOP PERFORMANCE TESTING. Prior to equipment acceptance, shop performance tests shall be conducted on the diffused aeration equipment to demonstrate that the equipment meets specified oxygen transfer and airflow rate requirements. Shop performance tests shall be conducted on the aeration equipment in the diffuser configuration representative of the full-scale system. Only the configuration used for Zone 1 shall be tested. The diffusers used in the shop test shall be from the same manufacturing run from which the diffusers used for the full installation are supplied.

Personnel in charge of the tests shall be competent, authorized representatives of the equipment manufacturer who are familiar with operation of the equipment furnished and who have previous satisfactory experience in conducting tests of the type specified. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results.

All testing shall occur at the manufacturer’s test facility or at a facility identified by the manufacturer. All costs associated with the testing are the responsibility of the manufacturer. The equipment manufacturer shall provide all other support facilities which shall include, but not be limited to, power, equipment, chemical storage tanks, mixing equipment, chemicals for dissolved oxygen determinations by the modified Winkler method, chemicals for K_La determination by the nonsteady state sulfite method, DO probes, scales, and such other equipment and facilities as may be necessary.

Dissolved oxygen concentration measurements shall be made with direct reading instruments which have been standardized against a laboratory determination of dissolved oxygen as described in the latest edition of "Standard Methods for Examination of Water and Waste Water", with appropriate modification for interfering substances. One direct reading instrument shall be provided for each point as shown on the Figure 2-46 51 31. Each instrument shall have a probe cord of adequate length.

At least two weeks prior to the proposed testing date, the equipment manufacturer shall notify Design-Builder of the testing date and shall submit a report detailing the proposed performance testing and analyses.

3-3.01. Test Procedures. The shop performance tests shall be performed in accordance with the requirements specified herein, in water from a potable water source, and a water temperature between 59°F and 77°F. With permission from Design-Builder, the manufacturer may proceed with the test at water temperatures outside this range; however, no changes in the test procedures or data analysis will be allowed to compensate for changing the temperature

A minimum of three tests shall be conducted at the maximum airflow conditions specified. One test shall be conducted at the minimum airflow condition, and one additional test at an airflow rate approximately midway between the minimum and maximum conditions, in order to plot the specified performance curves. The tests at the maximum airflow conditions shall be conducted first.

The data to be determined in each test shall include, but not be limited to:

Airflow rate in scfm.

Air supply temperature and pressure.

Rate of change of the dissolved oxygen concentration preceding, during, and following DO depletion.

Liquid temperature.

Uncorrected barometric pressure.

Pressure at top of drop pipe.

Additional data as necessary to determine compliance with the specifications.

Before each test, the aeration system should be operated for a period of time at the test airflow rate to achieve steady state conditions.

A 10 percent, by weight, solution of cobalt chloride ($CoCl_2$ $6H_2O$) shall also be prepared for the initial series of tests. About 34 lbs of cobalt chloride will be required per million gallons to obtain a cobalt ion concentration of one milligram per liter. For test purposes, the cobalt ion concentration shall be 0.5 mg/L or less.

For the initial series, the cobalt chloride solution shall be introduced into the tank with the diffused aeration system operating. After a minimum of 15 minutes of operation, addition of the sodium sulfite solution shall be started slowly. It will not be acceptable to turn down the air to achieve better deoxygenation with sodium sulfite. The entire quantity of sodium sulfite solution shall be added to the tank

within a period of approximately 5 minutes in a manner achieving uniform dispersion throughout the tank.

In each test, sodium sulfite shall be added to the water to deplete the oxygen concentration to zero, and maintain the zero condition for at least one minute. A 10 percent, by weight, solution of sodium sulfite (Na_2SO_3) shall be prepared in sufficient quantity to deplete and maintain the zero condition for one minute on all probe readouts simultaneously. Stoichiometrically, about 75 lbs of 96 percent pure sodium sulfite will be needed per million gallons to deplete the oxygen concentration one milligram per liter. A minimum of 150 percent of the stoichiometric concentration is typically required to achieve and maintain zero conditions for one minute. Technical grade sodium sulfite, free of catalyst, shall be used.

Data shall be recorded that shows oxygen depletion. The data shall also show that all test points remained at zero dissolved oxygen for at least one minute simultaneously. The test shall be considered invalid if zero dissolved oxygen is not reached for at least one minute at all test points simultaneously.

After the first tests have been completed, another batch of sodium sulfite shall be prepared and the procedure repeated. No additional cobalt chloride solution should be required after the first series. Should additional chemicals be required, they shall be provided at no additional cost to Owner. No more than ten tests shall be made with the same test water.

The equipment shall be operated to reaerate the water until oxygen saturation is reached. Dissolved oxygen concentrations shall be monitored continuously during the depletion and the reaeration periods. Dissolved oxygen concentrations shall be recorded at equal increments of approximately one minute, or at a time interval which provides at least 15 readings between 10 and 90 percent of the measured DO saturation value, but DO-time data shall be recorded during DO depletion and over the full aeration time. The temperature of the test liquid shall be recorded before and after each test run. Cobalt ion concentration of the test water will be measured after completion of tests by an independent testing laboratory and the test paid for by Owner. Points of dissolved oxygen measurements shall be as indicated on Figure 2-11570.

3-3.02. Flow Meters. The measurement of airflow rate shall be made with suitable flow metering equipment provided by the equipment manufacturer. The flowmeter shall be acceptable to the Design-Builder.

3-3.03. Data Analysis. The dissolved oxygen deficit from saturation (C_s-C_t) for each measurement point shall be calculated and plotted on semilog paper versus time (t) where C_t is the measured oxygen concentration at any time (t), and C_s is the average dissolved oxygen concentration, at temperature T, attained by aerating the basin contents until no further increase in dissolved oxygen

concentration is detected. A line of best fit shall be drawn utilizing regression analysis on all points. A sample of such a plot is provided for reference only on Figure 1-46 51 31.

The overall oxygen transfer coefficient $(K_La)_T$ for each point of measurement specified shall be computed by determining the slope of the line of the best fit by using the following equation:

$$(K_La)_T = \frac{\ln [(C_s-C_1) / (C_s-C_2)]}{t_2-t_1} \ (hr^{-1})$$

where:

T	=	water temperature, centigrade
C_s-C_1	=	initial (t_1) dissolved oxygen deficit, (mg/L)
C_s-C_2	=	final (t_2) dissolved oxygen deficit, (mg/L)
t_2-t_1	=	time span, (hr)
Cs	=	average of all dissolved oxygen concentrations, liquid temperature T, attained at each test location by aerating the basin contents until no further increase in oxygen concentration is detected, (mg/L)

The oxygen transfer rate constant for each measurement point shall be corrected to 20°C by the following formula:

$$(K_La)_{20} = (K_La)_T(\mu_T/\mu_{20})^{0.62}(h^{-1})$$

where: μ= absolute viscosity, (lb-sec/ft^2)

The individual values of $(K_La)_{20}$ from each test location for all three tests at maximum airflow shall be averaged and at least two-thirds of the individual $(K_La)_{20}$ values shall be within 10 percent of the average value. If not, additional tests shall be conducted until two-thirds of the $(K_La)_{20}$ values are within 10 percent of the average of all $(K_La)_{20}$ values.

The standard oxygen transfer rate by the aeration system shall be calculated by using the average value of $(K_La)_{20}$ in the following equation:

Standard Oxygen Transfer Rate = $8.34\ (K_La)_{20}\ V_B\ C_s\ (std)$ (lb/hr)

where:

V_B	=	aeration basin volume tested in million gallons
C_s (std)	=	the measured C_s value during the

performance testing corrected to standard conditions (20°C and sea level) and shall be determined by

C_s (std) = $[C_s] \times [9.09 / C_s(a)]^{1.146}$

where: C_s (a) = theoretical surface oxygen saturation value at test site barometric pressure and liquid temperature T, (mg/L)

C_s = measured oxygen saturation value at test site conditions, (mg/L)

The standard oxygen transfer rates, as determined by the performance tests, shall not be less than the values specified herein. The airflow rates used in the performance tests to meet the specified peak standard oxygen transfer rate values shall not exceed the values specified herein.

3-3.04. Test Performance Curve. The equipment manufacturer shall furnish a performance curve showing the relationship between oxygen transfer in pounds of oxygen per hour as a function of airflow in scfm over the full operating range of the equipment.

3-3.05. Modifications. If the diffused aeration equipment fails to satisfy the performance requirements, it shall be modified as needed. Modifications shall be made or additional equipment shall be furnished and installed as necessary to produce an installation which will satisfy the performance requirements. Additional airflow will not be an acceptable modification. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided and retesting shall be performed at no additional cost to Design-Builder. All structural or piping modifications necessary to accommodate the modified equipment shall be made at the equipment manufacturer's expense.

3-4. FIELD PERFORMANCE TESTING. Prior to equipment acceptance, field performance tests shall be conducted on the installed diffused aeration equipment to demonstrate that the equipment meets specified initial pressure loss through the system under design conditions, including water submergence from the top of the drop pipe.

Field performance tests shall be conducted at each diffuser grid under maximum month air flows. Temporary pressure gauges shall be installed in each grid drop leg for the test. A minimum of 3 readings per grid shall be taken for the test, with the average of these readings used for report purposes. The three readings shall be taken at 5 minute intervals, after 5 minutes of operation at the specified air flow.

Personnel in charge of the tests shall be competent, authorized representatives of the equipment manufacturer who are familiar with operation of the equipment

furnished and who have previous satisfactory experience in conducting tests of the type specified. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results. The report shall be submitted to the Design-Builder.

In the event of greater pressure losses than specified in any of the aeration grids during the initial test period, the manufacturer shall make approved modifications and retest at no additional cost to the Design-Builder. The equipment may be rejected if the specified pressure drop is not achieved following approved modifications and retesting.

3-5. TEST REPORTS. The equipment manufacturer shall prepare a test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder after completion of the specified tests.

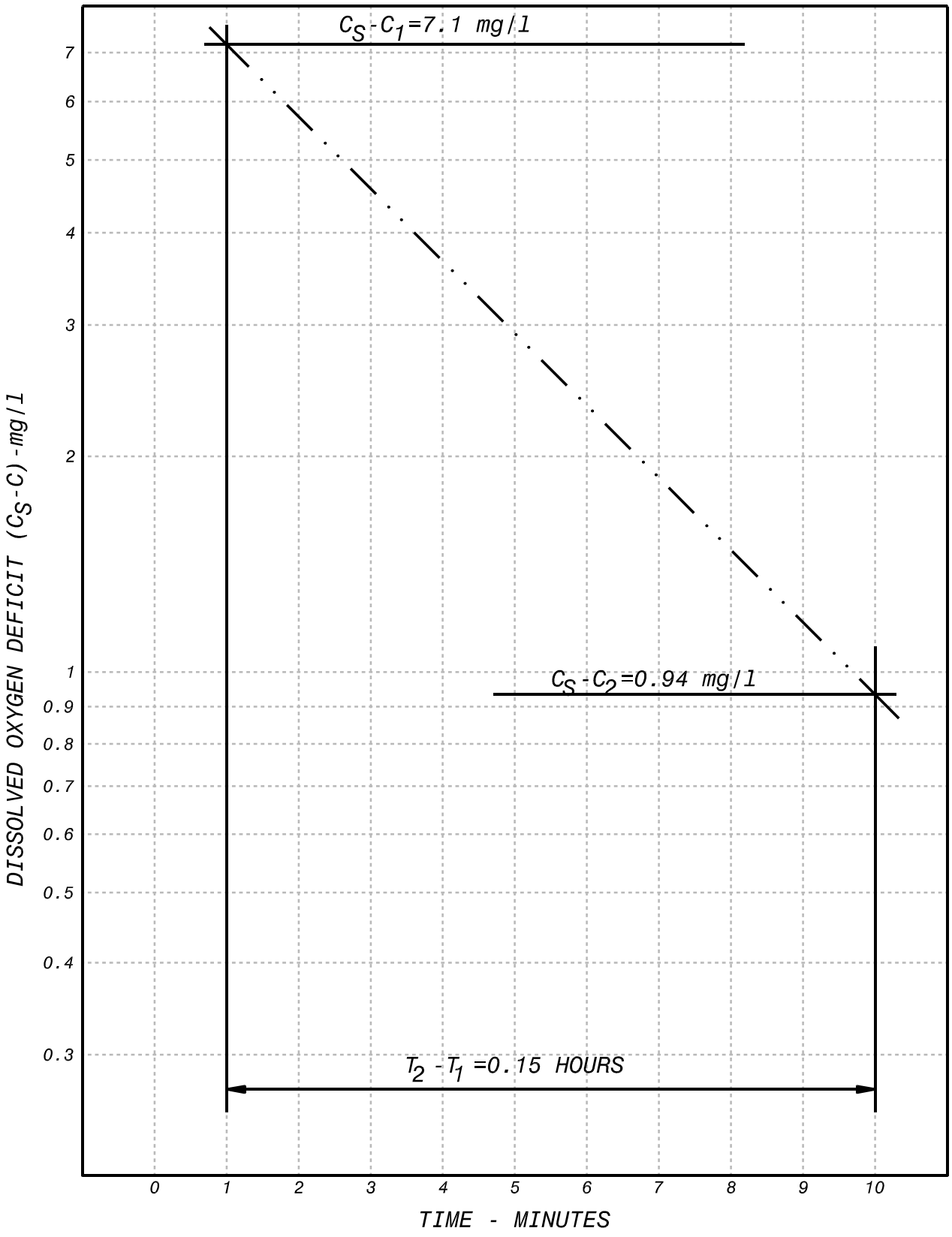
3-6. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer's expense.

3-7. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-7.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

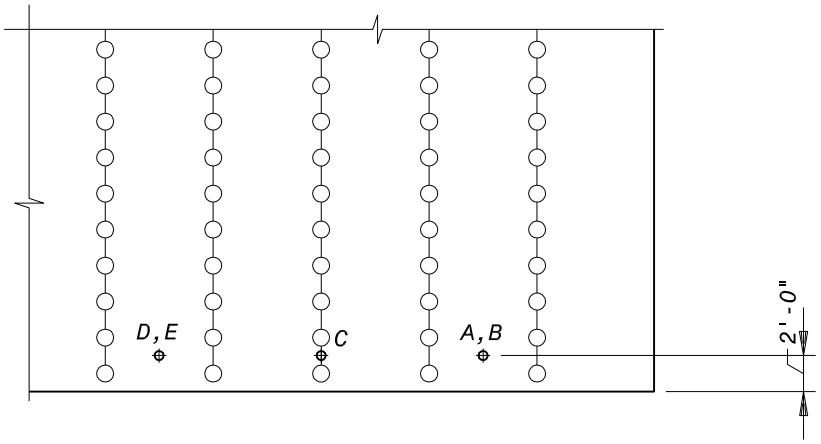
3-7.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section



SAMPLE PLOTTING OF OXYGEN TRANSFER DATA

BLACK & VEATCH	FLEXIBLE MEMBRANE DISC DIFFUSERS	FIG 1-46 51 31



POINT	LOCATION
A	2'-0" OFF BOTTOM, MIDWAY BETWEEN HEADERS
B	4'-0" BELOW SURFACE, MIDWAY BETWEEN HEADERS
C	BELOW DIFFUSER ASSEMBLY
D	MID-DEPTH, MIDWAY BETWEEN HEADER
E	2'-0" OFF BOTTOM, MIDWAY BETWEEN HEADERS

DISSOLVED OXYGEN MEASUREMENTS

BLACK & VEATCH	FINE PORE DIFFUSED AERATION EQUIPMENT	FIGURE 2-46 51 31

Section 46 61 41

DISK CLOTH FILTER

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing, installing, testing, and placing into operation a disk cloth filter, also referred to on this Project as the SAFE Filter.

Equipment designation.	SAFE Filter
Number of units.	1
Equipment tag numbers.	73-FLT-0001
Equipment location.	Area 70

The equipment shall be furnished through a single manufacturer and shall include, but not be limited to filter units, backwash pumps, sludge pumps, VFDs, electrical system, access platform as indicated on the Drawings, all piping internal to the filter basins and all valves required for automatic operation. Design-Builder shall provide piping to equipment as indicated on the Drawings. PLC based control systems, motor starters for all package driven equipment shall be included as part of the package.

Principal items included are:

Basin mounting brackets and hardware or structural frame
Steel Tank
Access platform along edge of tank
Access platform inside the tank for maintenance
Tie-off points for davits
Center tube
Disk drive assemblies
Backwash discharge assembly
Sludge discharge assembly
Scum discharge assembly
All valves and actuators
Filter local control panel (FLCP)
PLC, software and documentation
Instruments
Electrical and controls

Other components required for a complete functional system shall be provided by the filter manufacturer.

1-2. GENERAL. The filtration system shall be a disk cloth filter system specially designed for the removal of suspended solids and reduction of BOD to treat screened and degritted wastewater. The filtration system, including all equipment and appurtenances, shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings and Specifications, and engineering data, instructions, and recommendations of the filter manufacturer, unless exceptions are noted by Design-Builder.

1-2.01. General Equipment Requirements. The General Equipment Requirements shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Requirements Section, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria Section.

1-2.03. Power Supply. Unless otherwise specified, the power supply to the equipment will be 480 volts, 60 Hz, 3-phase, 3-wire. Where control voltage lower than the power supply voltage is required, a suitable control power transformer shall be furnished.

1-2.04. Equipment Identification. Equipment specified herein shall be tagged in accordance with the Equipment and Valve Identification Section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, together with detailed specifications and data covering material used, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications shall include, but not be limited to the following:

Dimensions and installation requirements.

Descriptive information, including catalog cuts and manufacturers' specifications for major components and effective filtration surface area.

Electrical schematics, connection and interconnection wiring diagrams, and layouts.

Complete motor information as specified in the Common Motor Requirements for Process Equipment Section.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

For system Controls, the data and specifications shall include, but not be limited to the following:

- Disk cloth filter control panel layout including interior and exterior views including dimensions.
- Accessory device data including catalog cut sheets on all control components.
- Bill of Materials.
- Detailed narrative on the filtration system operation.
- Wiring diagrams.
- Manufacturer and model.
- Catalog cuts of instrument data sheets.
- Materials of construction.
- Temperature rating.
- Special requirements.
- Operation and maintenance manuals.
- Installation details.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. COORDINATION. The filtration system shall be furnished by the filter manufacturer who shall coordinate the items of equipment, appurtenant systems, interconnecting piping, and controls to ensure the compatibility and proper operation of all items.

The filter manufacturer shall prepare system installation drawings, panel layouts, and other data required for complete system description and installation. The filter manufacturer shall verify that each system component is compatible with all other components of the system, that all pipe materials and sizes are appropriate, and that all devices necessary for a properly functioning filtration system have been provided.

1-5. SPARE PARTS. The SAFE Filter supplier shall propose a list of typical spare parts and pricing per the general Terms and Conditions.

PART 2 - PRODUCTS

2-1. SERVICE CONDITIONS. The SAFE Filter system will receive screened and degritted wastewater from the WRF Headworks Facility. The SAFE Filter shall perform as primary treatment to meet the performance and design requirements listed below. The filter is located outdoors and shall be supplied with a cover that is easily removable for maintenance.

2-2. ACCEPTABLE MANUFACTURERS. Filter equipment shall be manufactured by Aqua Aerobics Systems, Inc. or approved equal.

2-3. SYSTEM DESIGN. The SAFE System is designed to treat the influent flow downstream of the coarse screens and grit removal that exceeds the BNR-MBR treatment capacity. The flow enters a 100,000 gallon settling tank and when the settling tank fills, it overflows a weir and passes to the SAFE Filter. The SAFE Filter then treats the water by reducing BOD and TSS and sends the effluent to the outfall balancing tank, where it combines with the MBR filtrate before being disinfected and going to the ocean discharge under the NDPES permit. The system design shall be as follows:

	Required	Proposed
Total Number of Filter Units	1	1
Disk Filter Model Reference/Number	N/A	<FILL IN>
Number of Disks in the Filter	N/A	<FILL IN>
Filter Disk Size	N/A	<FILL IN>
Disk Cloth/Media Type	N/A	<FILL IN>

2-4. PERFORMANCE AND DESIGN REQUIREMENTS. Performance and design requirements to produce SAFE Filter effluent shall be as follows:

2-4.01. SAFE System Design Flow Requirement. The SAFE Filter shall be designed to treat flows up to the maximum flow defined below without overflowing, comprising the treatment system or reducing the treatment process performance efficacy described herein.

SAFE System Design Flow, mgd	≤ 6.26 MGD

2-4.02. SAFE System Design Loading Requirements. The SAFE Filter shall be designed with the following hydraulic and solids loading rates in the flow ranges defined.

	SAFE System Flow Range, mgd		
	≤ 3.5	≤ 5	> 5
Hydraulic Loading Rate, gpm/sf-active filtration area	≤ 3.5	≤ 4	≤ 4.5
Solids Loading Rate, lb/d/sf- active filtration area	7 - 12	5 - 7	4.3 – 6.5

2-4.03. SAFE System Performance Effluent Quality Requirements. The performance of the SAFE system will meet the requirements shown in the Table below.

SAFE Filter Effluent TSS	
When SAFE System Influent TSS > 80 mg/L	80% TSS Removal
If SAFE System Influent TSS ≤ 80 mg/L	≤ 40 mg/L
SAFE Filter Effluent BOD	
If SAFE System Influent BOD > 80 mg/L	50% BOD Removal
If SAFE System Influent BOD ≤ 80 mg/L	≤ 40 mg/L

2-5. FILTER SYSTEMS. Filter equipment shall be factory mounted on a support frame within a steel tank. Backwash and solids pumps may be field installed where required by the filter manufacturer's design.

2-5.01. Mounting Brackets. Mounting brackets for attachment of the filter components to the inside of the steel filter tank shall be 304 stainless steel. Stainless steel hardware required for installing the brackets shall be furnished by the filter manufacturer.

2-5.02. Drive Mechanism. Each filter shall include a drive with gearbox, drive sprocket, non-metallic drive chain with 304 stainless steel link pins, and a chain guard where the chain is exposed during normal operation. The gearbox shall be parallel in-line helical type, AGMA class 1. The drive motor shall have a maximum speed of 1800 rpm, shall be rated for 460 volt, 3 phase, 60 HZ, and shall be in accordance with the requirements of the Common Motor Requirements for Process Equipment Section.

2-5.03. Center Tube Installation. Each center tube shall be 3/16" thick 304 stainless steel, with driven sprocket, wheel assemblies and frame and cloth assemblies. The driven sprocket shall be multi segment made of U.H.M.W. polyethylene.

2-5.04. Filter Cloth Assemblies. Each disk cloth assembly shall be comprised of individual segments, each consisting of a cloth media sock supported by an injection molded polypropylene co-polymer or 304 stainless steel frame. Cloth/frame assemblies shall be constructed to allow easy on site removal and cloth replacement without use of special tools. All fasteners shall be 304 or 316 stainless steel.

During filtration, the filter unit shall operate in a static condition with no moving parts. The filter flow path shall be from the outside of the disk to the inside.

2-5.05. Backwash/Sludge Discharge Installation. The backwash system shall include a pump that draws filter effluent through the cloth, thereby removing accumulated solids from the cloth surface.

Each backwash and sludge discharge assembly shall include an external piping assembly, backwash system assembly, one backwash pump, and one solids pump as specified in Horizontal End Suction Centrifugal Pumps section. The external piping assembly shall include backwash valves, a 0-30 inches mercury vacuum gauge, and a pressure gauge. Vacuum and pressure gauges shall have a minimum 2.5 inch dial and shall be by Ashcroft or equal. The Design-Builder shall coordinate the provision of the backwash/sludge discharge assembly piping and the assembly installation with the filter manufacturer and coordinate the pump sizing. Piping within the filter basin shall be type 304L stainless steel as specified in Stainless Steel Pipe, Tubing, and Accessories Section and as indicated on the drawings.

The backwash assembly shall include 304 stainless steel backwash shoe supports with end springs, backwash shoes, 304 stainless steel backwash manifold, and a sludge collection manifold.

Filtering shall not be interrupted during normal backwashing and sludge discharge. Backwash isolation valves and throttling valves (as required) shall be provided as needed on the discharge of each backwash pump. These valves shall be tagged in accordance with the Equipment and Valve Identification Section.

All valves shall be Cast iron, ASTM 126, Class B; or ductile iron, ASTM A536, Grade 65-45-12 body plug valves with open/close electric actuators. Valves shall be manufactured by DeZurik, Pratt, Milliken, Val-Matic, Clow, Victaulic, or equal. Valve actuators shall be by the valve manufacturer, RCI by Rotork, TCI, or equal, and shall include a compartment heater and open and closed position limit switches.

2-5.06. Effluent Weir. The filter shall be provided with an effluent weir sized for the 100th Percentile Flow listed above and to fit into the overall Plant Hydraulic Profile as indicated on the Drawings.

2-5.07. Filter Disk Tank. The filter shall be provided with a painted steel tank assembly with a minimum thickness 10 gauge. The tank shall be in accordance with the Metal Fabrications section. Tank coating and lining shall be finished with manufacturer's standard materials.

2-5.08. Maintenance Appurtenances. The filter supplier shall provide davit tie off locations for workers to connect while inside the tank. In addition, the interior of the tank shall have a step for workers to stand on while maintaining disks.

2-6. CONTROLS.

2-6.01. Filtration System Control Panels. A filter master control panel (MCP) shall be located adjacent to the SAFE Filter and outdoor rated. A single local control panel or kiosk shall be provided with an operator interface terminal (OIT) (also referred to as a touch screen) to provide local control of filters. Provisions shall be made to shield the OIT by installing it flush mounted on an interior swing out or with appropriate sun shields. LCP enclosures shall be NEMA 4X and shall meet all requirements indicated in the Panels, Consoles, and Appurtenances section. The control panel shall be integral to the filter package and shall be suitable for the conditions specified herein. The filter control panel shall contain the necessary equipment, instruments, ancillary control devices, and programmable logic controllers (PLC) to perform the automation functions of the filtration system. The PLCs and OITs provided shall meet the requirements listed in Programmable Logic Controllers Section and herein. The cloth media filter MCP and LCPs shall be preassembled and pre-tested at the factory as a complete assembled unit. The control panels shall contain all necessary controls to control each cloth disk filtration unit provided. PLC controls shall be accessible through a touch screen control panel.

2-6.01.01. Control Panel Configuration. The filter control panel PLCs shall be programmed by the cloth media filter manufacturer to control the filters and send and receive signals to the Plant Control System (PCS). The cloth media filter supplier shall furnish a computer file copy of the PLC program, including an annotated version, and a printout of the PLC logic. The printout shall be documented to clearly indicate the function of each portion of the logic. In addition, the printout shall include memory usage documentation to indicate all memory locations used.

The cloth media filter manufacturer's PLC programmer or a representative of the manufacturer shall attend the initial configuration review meeting to be coordinated with the Design-Builder, with the meeting to be held at the Owner's facility. This meeting shall establish the configuration standards and conventions to be utilized by OEM suppliers and the PCS configuration contractor. Graphic screen development, address usage/naming conventions and report format standards shall be established as part of this meeting. Additionally during these meetings, data to be shared with the PCS from the cloth media filter PLC shall be

identified and data sharing procedures, address locations, and communications protocols shall be established. The shared information should be made available in contiguous registers in the PLC to facilitate communications.

All control system equipment shall meet applicable requirements of the Instrumentation and Control System section.

2-6.02. Controllers and Displays.

2-6.02.01. Programmable Logic Controllers. The Master filter control panel PLC shall include inputs and outputs as shown on the drawings, listed in the Input/Output listing, or as required by the cloth media filter manufacturer for control of the filters and the associated control valves and equipment. The PLC shall be provided with an Ethernet communications module and/or port and shall utilize the preferred communications protocol. CAT-6 Ethernet cables required for the MCP to make connection to the PCS will be supplied and installed by Design-Builder. The PLCs shall be provided as a complete, standalone system for comprehensive control of the disk cloth filtration system. The PLC's shall include all necessary modules and ancillary devices for communications to the PCS.

2-6.02.02. Operator Interface Terminals. Each cloth media filtration system master control panel and local control panel shall be supplied with an OIT installed flush mounted on the enclosure door. The OIT shall provide graphic screens that shall be used by the operators to access all functions and setpoints necessary for comprehensive control of each cloth media filter and the entire filter system (filter control panel). The Manufacturer shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored by the control system shall be displayed on one or more graphic screens. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. The manufacturer shall use the configuration standards and conventions to be established by direct coordination with the Design-Builder and Owner that shall describe and define such items as proposed graphic display process line colors/representations; color standards for "on", "off", "opened", "closed", and "alarm" conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup.

One licensed copy of the OIT software used to create the screens shall be turned over to the Owner upon successful startup and commissioning of the system.

An operator interface terminal (OIT) shall provide the following control and monitoring functions:

Backwash sequence initiation.

Filter out of service selection.

On-Off (green and red) indication for each motorized piece of equipment.

Alarm indication for failure of each piece of driven equipment and filter high level.

Local-Off-Auto selection for the filter and Start-Stop selection for each piece of motorized equipment and Open-Close selection for each valve, where applicable.

Filter backwash in progress indication.

Sludge removal in progress indication.

Scum removal in progress indication.

Filter level indication where applicable.

Elapsed time since last wash.

Backwash interval and duration setpoint entry.

Sludge wasting interval and duration setpoint entry where applicable.
In service/out of service selection. When out of service is selected, the filter functions shall be inhibited.

Timer settings and analog values shall be retained when power fails.

In addition to the OIT, the following electromechanical controls and devices shall be provided on the face of the cloth media filter master control panel. Control shall be provided for each filter supplied:

Backwash sequence initiation push button.

Elapsed time meters for each piece of motorized equipment excluding valves.

On-Off (red and green) indicating lights for each motorized piece of equipment.

Amber alarm indicating lights for failure of each piece of driven equipment and filter high level.

Local-Off-Auto selector switch for the filter and Start-Stop selector switch for each piece of motorized equipment and Open-Close selector switch for each valve, where applicable.

White Backwash in Progress light.

Filter level indicator where applicable.

Elapsed time meter for time since last wash.

Backwash interval and duration setpoint devices.

Sludge wasting interval and duration setpoint devices where applicable.

In service/out of service selector switch. When out of service is selected, the filter functions shall be inhibited.

2-6.02.03. Filter Controls. The backwash cycle shall be initiated on one of the following conditions:

Operator specified time interval elapses

Operator selects a manual backwash cycle

High level

Where applicable, the sludge cycle shall be initiated on one of the following conditions:

Operator specified time interval elapses

Operator specified backwash counts elapses

Operator selects a manual sludge cycle

The scum cycle shall be initiated on Operator specified time interval elapses.

Each motor and valve shall be operated in the following modes:

Automatic mode through the filter PLC.

Manual mode through the filter control panel.

Open/Close limit switches for electric actuated valves shall be wired to the PLC for position monitoring.

2-6.02.04. Interface to Plant Control System. In addition to performing the disk cloth filter control functions, the MCP PLC shall be directly connected to the PCS. Data to be transmitted between the MCP PLC and the PCS shall meet the requirements indicated in the Software Control Block Description section and as indicated herein. Data to be communicated with the PCS shall be stored in contiguous blocks of memory in the MCP PLC to facilitate the data transfer.

The following data points from the filter control panel to the PCS shall be provided via an Ethernet data network connection:

Inputs:

Backwash pump running and fail – each pump.

Drive running and fail.

Backwash Initiation

Backwash in progress.

Backwash sequence fail.

Filter out of service.

Filter level high.

Filter Level

Filter Elapsed Time Since Last Backwash

Outputs:

Initiate Backwash

In Service/Out-of-Service Initiation

Enable Backwash

Additionally, the controls shall accept a remote “Emergency Backup Power” signal from the plant control system. When this contact has been asserted or enabled, the disk cloth filter control system shall only allow one disk cloth filter unit to backwash at a time. Simultaneous backwash sequences shall not be permitted.

A list of recommended data point addresses to be monitored by and written to by the PCS shall be provided by the Manufacturer prior to the coordination meeting for MCP/PCS coordination specified above.

An industrial Ethernet switch that meets the requirements as listed in the Network Systems Section shall be provided in the MCP to allow for a single connection to the PCS. All CAT 6 cabling, terminations, jumper cables and other pertinent devices for complete and operational disk cloth filter PLC network communications shall be provided by the disk cloth filter system supplier.

The disk cloth filter system supplier shall coordinate with the Design-Builder's Configuration Contractor to establish a secure network access to the disk cloth filter system equipment via a VPN connection. Any additional hardware required to implement VPN access to the disk cloth filter system provided equipment shall be provided by the disk cloth filter system supplier.

2-6.02.05. Fiber to Copper Converters. Fiber optic to copper media converters for the LCP networks shall convert twisted pair 10/100BaseT cable transmissions to 10/100BaseFX fiber optic cable transmissions. Converters shall provide auto-sensing detection of network speed and full duplex or half duplex signaling. Converters shall have diagnostic LEDs for network speed and network traffic. Converter copper port shall be 100BaseTX (RJ-45). Converter fiber port shall be compatible with connectors provided with fiber cable jumpers and compatible with fiber cable type and light wavelength. Transmission Speed shall be 100Mbps on both ports. The converter shall be powered from 120 volts ac, or shall be provided with a plug-in transformer to provide the required voltage to the device. Converters shall be as manufactured by Transition Networks, D-Link, Black Box, or equal.

2-6.02.06. Uninterruptible Power Supply. An uninterruptible power supply (UPS) shall be furnished for each MCP to power the equipment in the PLC cabinet on a power loss.

A relay or other means of indication shall be provided and connected to the respective PLC which will alert the Plant Control System of a power loss and PLC cabinet is operating on UPS power. Disk cloth filter manufacturer shall be responsible for coordinating the size of the UPS unit with the equipment furnished herein to provide backup power for a minimum of 30 minutes. A ground fault protected convenience outlet shall also be included in the panel.

2-6.02.07. Device Tagging. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the Instrument Device Schedules and with the supplier's equipment Drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags.

Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

Permanent nameplates shall be as specified in the Equipment and Valve Identification Section 01615.

2-6.03. Electrical Requirements. Each Electrical panel shall include a main 480 volt, 60 Hz, 3 phase circuit breaker, combination thermal-magnetic circuit breaker type motor starters for each constant speed motor, and variable frequency drives for variable speed motors where applicable. All circuit breakers shall be rated 42,000 amperes interrupting capacity at 480 volts ac. Control voltage for motor starters, relays, timers, and auxiliary devices shall be 120 volts, single phase from control power transformers in the panel. The control circuit shall have both primary leads fused, one secondary lead fused and the other secondary lead grounded. Motor starters shall have three overload relays, one in each phase correctly sized for the motors furnished. Motor starters shall be NEMA rated for the horsepower of the motor. Electrical panel main circuit breaker shall be sized for the three filters specified herein and for a fourth future filter. Electrical panel shall have sufficient space within the enclosure to house additional motor starters, fuses, contactors, and branch circuit breakers to power the future fourth filter equipment.

Auxiliary relays shall be heavy-duty, industrial type with 120-volt ac coil and output contacts rated 10 amperes at 120 volts ac.

Selector switches, indicating lights, and push buttons shall be heavy-duty, oil tight, push-button station type with contacts rated 10 amperes at 120 volts ac and shall have engraved or etched nameplates identifying the application and each switch action. Indicating lights shall be push-to-test, full voltage type with LED

lamps. All pilot devices shall be 30.5 mm and shall be rated in accordance with the enclosure.

Elapsed time meters for equipment shall be synchronous motor drive, 99,999.9 hours span, non-resettable, and 120 volts ac. Elapsed time meter for time since last wash shall be 120 volts synchronous motor driven, resettable, and shall display time in minutes.

The panel shall be factory tested by the panel fabricator before shipment.

The panel shall be a NEMA Type 4X 316 stainless steel enclosure and shall be sized for four filter units. If individual LCPs are not provided, then electromechanical controls are to be provided on the face of the panel and space shall be allocated for a future fourth filter unit.

All outdoor panels shall have panel mounted air-conditioning unit to cool.

2-6.03.01. Power and Control Wiring. The control panel shall be completely wired with provisions for terminating all remote wiring on terminal blocks. The terminal blocks shall be marked to agree with the panel wiring diagram. Control terminal blocks shall be sized for No. 14 AWG or No. 16 AWG copper wire. All interconnecting wiring and wiring to terminals for external connection shall be not less than No. 14 AWG copper for control and No. 12 AWG for power, insulated for not less than 600 volts with a moisture and heat-resistant material and flame-retardant nonmetallic covering. All wiring shall be grouped or cabled and firmly supported to the panel, and shall be numbered at each termination with permanent labels corresponding to the schematic. Not less than 10 percent spare terminals shall be provided.

2-7. FILTER INSTRUMENTATION. The filter manufacturer shall provide all instrumentation required for operation of the filter.

All instrumentation used in the filter system for control or monitoring shall be individually fused or circuit breaker protected to minimize the effects of any single point of failure. Instrumentation shall be installed in accordance with filter manufacturer's instructions.

2-7.01. Fixed-Mount Float Type Level Switches. Float switches shall be furnished in accordance with Pressure and Level Instruments section.

2-7.02. Submersible Pressure Sensing Level Transmitters. Submersible pressure sensing level transmitters shall be furnished in accordance with the Pressure and Level Instruments section.

2-7.03. Ultrasonic Level Transmitters. Ultrasonic level transmitters shall be furnished in accordance with the Pressure and Level Instruments section.

PART 3 - EXECUTION

3-1. INSTALLATION. This equipment shall be installed in accordance with the Equipment Installation section and the Disk Cloth Filter manufacturer's requirements and recommendations.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as

often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily and in accordance with the specified performance requirements.

All costs for these services shall be included in the contract price.

3-3. PROCESS PERFORMANCE GUARANTEE AND TESTING.

3-3.01. Guarantee. The cloth filter system shall be guaranteed to produce the filter effluent water quality requirements in accordance with the performance and design requirements specified herein at all listed flow conditions. To assess compliance with the specified effluent requirements, performance testing shall be conducted. All pre-checks, mechanical tests and preliminary tests will need to be completed and approved by the Design-Builder and manufacturer prior to performance testing.

3-3.02. Mechanical Test. A mechanical test shall be conducted by the Design-Builder under supervision of the filter manufacturer's representative after the equipment start up is complete.

The manufacturer shall provide a detailed mechanical testing protocol and procedure with the requisite checklists prior to the mechanical testing.

Any malfunctions or defects appearing during the tests shall be corrected and additional testing performed, as directed by the filter manufacturer's representative, to demonstrate satisfactory operation.

3-3.03. Field Performance Test (Effluent Quality). Acceptance of the mechanical test results is required before field performance testing can begin. The performance test shall demonstrate the system performs in accordance with the requirements specified in section 2-4.

The performance test will be conducted using a simulated SAFE System Influent produced by blending potable water (dechlorinated) with Influent to the Morro Bay WRF. A minimum of two performance tests will be conducted in order to evaluate system performance (headloss, removals and effluent quality) as required in this specification.

The Design-Builder will coordinate development of a detailed testing plan prior to delivery of equipment. A minimum of 60-days prior to commencing the performance test(s), the vendor must provide to Design-Builder a detailed

description of how filter system will operate during the performance test. Sampling and sample analysis shall be provided by the Design-Builder through a laboratory certified in the state of California. As part of the tender submission, the vendor shall provide a sample performance test plan (or a performance test plan specific to the Morro Bay WRF SAFE System) for consideration by the Design-Builder.

Hydraulic loading rate (gpm/sf) shall be determined using the effluent flow rate divided by the number of filters in service divided by the effective submerged filtration area of each filter.

The performance test shall be supervised by an authorized representative of the filter manufacturer familiar with operation of the equipment furnished and having experience in conducting primary filtration performance tests. Qualified personnel shall operate the filtration equipment, record the data, make the required calculations, and prepare the test report.

3-3.03.01. Test Procedures. The test procedure requirements, including the flow scenarios, duration, and sampling points will be determined in the future with input from the filter manufacturer.

Discrete samples shall be taken each day of testing on both the filter influent and effluent. Each sample, whether influent, effluent, or backwash shall be tested for total suspended solids (TSS) and BOD. Sampling and field quality control procedures shall be in accordance with the requirements of 40 CFR part 136.

The minimum data to be obtained in each test shall include:

Backwash flow rate based on actual pump rate.
Backwash duration.
Hydraulic loading rate (gpm/sf).
Maximum solids loading rate (ppd/sf).
Total suspended solids removal (pounds per day).
Total BOD removal
Backwash frequency (backwash/day).
Total forward flow (calculated)
Power consumption for each phase throughout the testing period

The performance requirements of the filtration process will be met when the system produces an effluent within the specified limits 100 percent of the time for the specified duration and hydraulic loading of the test.

3-4. TEST REPORTS. The equipment manufacturer shall prepare a test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder within 30 days after completion of the specified tests.

3-5. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment manufacturer's expense.

3-6. TRAINING. The equipment manufacturer shall furnish the services of a competent and experienced operator of the equipment who is qualified to instruct Owner's operating personnel in the proper operation and maintenance of the equipment in accordance with the equipment manufacturers recommendations. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-6.01. Operations Training. Classroom instruction covering the theory and practical application of operation, site specific operation and inspection of the equipment and optimization of the equipment operation.

3-6.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

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Section 46 76 21

BELT FILTER PRESSES

PART 1 - GENERAL

2-1. SCOPE. This section covers furnishing and installing of one belt filter press (BFP) unit, including accessories and appurtenances, in the sludge dewatering facility at the residual area. The press shall be used to dewater waste activated sludge from the sludge holding tanks or directly from the MBR system to increase total solids concentration. The single Dewatering System Supplier (DSS) shall provide all equipment listed herein for a fully functioning dewatering system. The Design-Builder shall coordinate the design of the BFP system with the requirements specified herein.

2-2. GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment Manufacturer, unless exceptions are noted by the Design-Builder.

Each belt filter press system shall consist of, but not be limited to, a dewatering belt filter press, sludge conditioning unit, belt alignment/tensioning system, belt wash spray water booster pump if required, electrical and control system, feed pumps, polymer feed system and any additional appurtenances required by the Manufacturer's design and in compliance with the intent and purpose of the sludge dewatering system. Control equipment furnished herein shall meet the requirements specified in the Programmable Logic Controllers section.

All appurtenances required for proper operation of the belt filter press equipment and not otherwise specified shall be furnished and installed as recommended by the MANUFACTURER.

1-2.01. Acceptable Manufacturers. Belt Filter Press equipment Manufacturer shall be Komline-Sanderson, BDP, Charter Machine Company, Ashbrook or equal if approved.

1-2.02. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section.

1-2.03. Coordination. The responsibilities for both Design-Builder and Manufacturer shall include, but not limited to, the following:

Item	DESIGN-BUILDER	DEWATERING SYSTEM SUPPLIER
Transportation and Unloading	Responsible	Coordinate
Installation	Responsible	Check
Performance Testing	Coordinate	Responsible
Startup	Coordinate	Responsible
Training	Coordinate	Responsible
Submittals	Coordinate	Responsible
Layout	Coordinate	Confirm layout with process piping, mechanical and electric/ electronic equipment.
Drawings	Coordinate	Furnish fully coordinated set of drawings with all proposed changes for proper installation
Polymer Feed System	Coordinate	Responsible
Conveyors	Coordinate	Responsible
Process feed and drain piping	Responsible	Coordinate
Chutes and Hoppers into dumpster	Coordinate	Responsible
Process equipment (feed/discharge pumps)	Coordinate	Responsible
Electric Equipment	Coordinate	Responsible for all related controls, motors, VFD’s, appurtenances and enclosures

The responsible party shall provide equipment and arrange installation.

1-2.04. Power Supply. Power supply to the equipment will be 480 volts, 60 Hz, 3 phase.

1-2.05. Hardware. All hardware, including but not limited to anchor bolts, nuts, washers, cotter pins, adjustment screws and rods, sidecover hardware, handles, and hinges, shall be Type 316 stainless steel and shall comply with the Anchorage in Concrete and Masonry section.

1-2.06. Piping Connections. All connections to piping (except drain pans) shall be flanged connections and shall conform to the diameter and drilling of ANSI/ASME B16.1, Class 125. Flanges shall be flat faced.

1-2.07. Coating Repairs. Damage to coating systems prior to acceptance by the Design-Builder at delivery shall be repaired by the MANUFACTURER at no additional cost. Any coating repairs after delivery and acceptance onsite and due to installation of the BFP equipment shall be the responsibility of the Design-Builder and shall be performed according to the paint MANUFACTURER's recommendations.

1-2.08. Welding. All welded joints exposed to view or in contact with the process shall be sealed watertight by continuous welds.

1-2.09. Edge Grinding. Sharp corners of cut or sheared edges shall be dulled by at least one pass of a power grinder.

1-2.10. Surface Preparation. All ferrous metal surfaces, except motors, speed reducers, and stainless steel, shall be shop cleaned by sandblasting or equivalent, in conformance with the paint MANUFACTURER's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

1-2.11. Maintenance Equipment. The MANUFACTURER shall supply all special tools required for servicing and disassembly of the equipment.

1-2.12. Corrosion Protection. All surfaces shall be made of corrosion-resistant materials or shall be protected with shop applied corrosion protection systems. The materials or protection systems shall adequately protect the equipment and appurtenances from corrosion caused by the service environment including sewage sludge, and chemicals such as polymers.

Information regarding the proposed corrosion protection systems shall be submitted to the Design-Builder. Sole responsibility for choice of materials and corrosion protection systems, including application, shall rest with the Manufacturer. The information provided to the Design-Builder shall include materials, methods of application, maintenance requirements, and other pertinent

data.

1-2.13. WARRANTY. All equipment shall be new and in accordance with the general Terms and Conditions.

1-3. SUBMITTALS.

1-3.01. DRAWINGS AND DATA. Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering material used, parts, devices, schematic wiring diagrams, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the submittals section.

Detailed information regarding the corrosion protection systems shall be provided for record purposes, including materials, methods of application, maintenance requirements, and other pertinent data.

Electrical connection diagrams and schematics identifying and describing all items required for operation of the equipment shall be submitted for review. Submittals shall verify each applicable feature in this specification and in the General Equipment Stipulations.

The data and specifications for the unit shall include, but shall not be limited to, the following:

Belt Filter Press

Name of Manufacturer.
Type and model of unit.
Weight and dimensions of major equipment components.
Guaranteed produced solids concentration
Operating weight.
Description of gravity drainage, wedge, and compression zones.
Sludge conditioning unit details.
Wash water strainer, piping, nozzle details.
Sludge feed, wash water, and filtrate drainage connections.
Details of belts, tensioning devices, alignment devices, and speeds.
Type, make, and full details of all bearings.
Certified calculations by bearing MANUFACTURER showing that all bearings comply with the specified requirements for ABMA L_{10} bearing life at maximum dynamic loadings and for the intended service and design conditions.
Gear, chain, shaft, and hydraulic drive unit, if used.
Complete assembly and installation drawings with detailed specifications and data for the hydraulic power.
Lubrication system.

Discharge details.
Drainage system.
All material types, thicknesses, and finishes.
Details of all control and sensing devices.
Details and dimensions of equipment layout and anchor bolt location.

In addition, the following information is to be supplied for the baseplate on each piece of equipment. The loads shall include all horizontal and vertical components.

a. Dead loads due to unit weight empty.
b. Dead loads due to unit weight full of sludge, drain pans full, etc.
c. Dynamic loads.
d. Combination of "b" and "c" above.

Motors

Name of Manufacturer.
Type and model.
Type of bearings and method of lubrication.
Rated size of motor, hp, and service factor.
Temperature rise and insulation rating.
Full load rotative speed.
Net weight.
Full load current.
Locked rotor current.
Efficiency at full, 3/4, and 1/2 loads.
Power factor at no load and at full load.
Motor space heater details.
Base details.

Spray Water Booster Pump (as required)

Name of MANUFACTURER.
Type and model.
Rotative speed.
Size of suction nozzle.
Size of discharge nozzle.
Statement from DSS outlining wash water requirements, including min and max flow and min and max pressure.
Complete performance curves showing capacity versus head, NPSH required, pump efficiency, and bhp.
Data on shop painting.

Control Panels

Dimension and layout details.
Materials of construction for panels and all associated hardware.

Detailed list of panel components.
Wiring diagrams and control schematics.
List of hardware required for PLC programming.
PLC program file and ladder logic printout program, software and license.
Sequence of operations.
Catalog cut sheets on all components.
Conduit interconnection diagram.
Narrative description of the sequence of operation in the manual and automatic modes.
Operator interface terminal programming and screens.

Variable Frequency Drive.

Name of Manufacturer.
Types and model numbers.
Rated drive input kVA and output kVA.
Percent efficiency at 100 percent speed and 60 percent speed.
Maximum Btu [kJ] heat release data and verification of the drive cooling requirements.
Total weight and lifting instructions, height, mounting, and floor space required.
Panel interior and front and side exterior view details showing maximum overall dimensions of all transformer, bypass contactor, ac line filter, ac line reactor, and drive compartments.
Schematics, including all interlocks.
Wiring diagrams, including all internal and external devices and terminal blocks.
Locations and sizes of electrical connections, ground terminations, and shielded wires.
List of diagnostic indicators.
List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.
List of standard features and options.
List of spare parts to be furnished.
Input line protection model numbers and Manufacturer's data sheets.

Polymer Feeder Blender Equipment

See submittal requirements in the Polymer Feeder Blender Equipment section

Screw Conveyor

See submittal requirements in the Screw Conveyors section

Dewatering Sludge Feed Pumps

See submittal requirements in the Rotary Lobe Pumps section

Miscellaneous

Type of factory-provided conduit and cable.
Six copies of the Field Evaluation Test Report.
Schematics and connection diagrams for all electrical equipment shall be submitted for review. A Manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.
Complete assembly and installation drawings for the platforms and ship's ladders with dimension and layout details.
Materials of construction for the platforms and ship's ladders.

1-3.02. Operation and Maintenance Data and Manuals. The Dewatering System Supplier shall furnish complete O&M manuals to install, operate, maintain, and lubricate each component of mechanical and electrical equipment. The manuals shall comply with the requirements described in the Submittal Procedures section.

1-4. QUALITY ASSURANCE.

1-4.01. Manufacturer's Field Services. The DSS shall provide the services of a factory field engineer to initially check installation of the BFP and to place the BFP in service in accordance with the quality control section. The field engineer shall also be responsible for instructing operating personnel as to proper process and maintenance procedures.

1-5. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Shipping section. Handling and storage shall be in accordance with the Handling and Storage section. BFP shall be lifted and handled as recommended and directed by the DSS.

1-6. EXTRA MATERIALS.

1-6.01. Spare Parts. The Belt Filter Press Supplier shall propose a list of recommended spare parts and pricing per General Terms and Conditions.

PART 2 – PRODUCTS

2-1. PERFORMANCE AND DESIGN REQUIREMENTS.

2-1.01. Service Conditions. Waste activated sludge (WAS) will be pumped from the Sludge Holding Tanks or directly from the BNR/MBR system to the BFP to perform dewatering to remove water and increase total solids concentration. The Sludge Dewatering System shall convey solids from the dewatering equipment to a rolloff container (container provided by others) with minimal exposure for odor release. The BFP shall be furnished to dewater WAS sludge down to a water

content suitable for hauling and disposal as specified below.

Sludge will be pumped to the BFP(s) using rotary lobe positive displacement pumps equipped with variable frequency drives.

A polymer system using a liquid emulsion polymer will be used to aid in dewatering of the feed solids.

Dewatered cake will discharge to a series of screw conveyors as indicated on the Drawings. Filtrate will flow in a pipe by gravity to a floor drain connection in the dewatering area after which it will flow by gravity to the plant sewer and then be returned to the head of the WRF.

2-1.02. Sludge Characteristics. Under the majority of conditions, the belt filter press feed is WAS from the BNR-MBR process. During wet weather events, solids from the auxiliary treatment system will be blended with the WAS. Auxiliary treatment consists of a small settling tank and disk filter system. The BFP(s) shall be designed to dewater sludge with the following characteristics:

	Unit	Value
Feed solids percent of total solids	% TS	0.6-1
Feed volatile solids percent of total solids	% VS	60-70
Feed solids temperature[1]	°C	18-24

[1]Note that maximum, minimum, and average temperatures may not correspond with maximum, minimum, and average solids feed conditions.

2-3. POLYMER SELECTION. Polymer selection will be determined by the DSS. Polymer will be supplied by the DSS for performance testing requirements.

2-4. PERFORMANCE AND DESIGN REQUIREMENTS.

2-4.01. Performance Requirements. The dewatering system shall be designed to operate under the following criteria:

Unit designation	DWT-BFPS-0001
Number of units	1
Minimum effective belt width, meters	2.0
Normal operation	
Days per week	2
Hours per day	8
Polymer dose range, lb active/dt	25 to 35

Minimum cake solids, % TS 17%

Minimum capture rate, % 95%

	AA	MM
Anticipated Feed Solids, mg/L[1]	8,400	8,600
Anticipated HLR, gpm/machine	245	325
Anticipated SLR, pph/machine	1,030	1,400
[1]Note that the range of design feed solids may not be identical to the minimum and maximum solids concentrations listed in Section 2.2		

Maximum allowable HLR, gpm/machine	<DSS Fill-in>
Maximum allowable SLR, gpm/machine	<DSS Fill-in>

Exceptions to the capture rate and concentration due to the volatile content or feed solids concentration should be clearly stated in the submittal information.

2-4.02. Design Requirements. Each belt filter press shall be a complete dewatering unit consisting of the following main components:

Structural frame and roll components.
Belts and belt washing system.
Belt discharge.
Drain pans.
Inlet pipe and distribution box assembly.
Automatic belt alignment/tensioning systems.
Sludge conditioning unit.
Terminal box and alarm/control panel.
All other components as illustrated in the Drawings that are required to be provided by the DSS.

The belt filter presses shall consist of multistage dewatering section and shall be factory assembled as completely as possible, including piping and wiring, so that a minimum number of external connections are required. Each unit shall be mechanically tested and adjusted prior to shipment from the factory. The presses shall be shipped and stored, if required, in the disassembled configuration. If disassembly is required, the components shall be match-marked to assure that each press is reassembled with the same components as when shop tested.

The reassembly and installation shall be completed by the combined and coordinated efforts of the installation Design-Builder and qualified representatives of the belt press Manufacturer. As a minimum, the qualified representatives shall oversee the procedure and shall assure that the units are properly reassembled. Sludge shall be conditioned with polymer prior to introduction to the belt filter

press. Polymer shall be introduced to the sludge flow through a polymer injection ring at the location as shown on the Drawings. If a different location is recommended by the Manufacturer, it shall be coordinated with the Design-Builder. Sludge and polymer shall then be further mixed in a sludge conditioning unit prior to introduction to the belt filter press. The mixing shall take place by the turbulence created through the pressure drop as the sludge flows into the conditioning unit, and retention time shall be based on optimum flocculation.

Conditioned sludge shall be evenly distributed onto the independent gravity drainage belt through an inlet distribution assembly. The thickening section in each unit shall allow gravity drainage of the free water through a belt filter. The belt shall be supported on high density polyethylene (HDPE) or ultra high molecular weight (UHMW) polyethylene strips within stainless steel drainage grids. Two deckle strips shall be provided to contain the sludge flow within the gravity drainage zone. The deckle strips shall be fabricated from 316L stainless steel or fiberglass reinforced plastic bars with adjustable neoprene or rubber

edge seals. The edge seals shall not damage or cause excessive wear of the belt.

A minimum of six (6) rows of furrowing devices or plows, with lifting handles, shall be employed to promote sludge thickening and to ensure an even distribution of sludge across the entire width of the belt. The plows shall be of a design to minimize belt wear. Each row of plows shall be provided with a single lifting handle, designed to remove the entire row of plows at least 6 inches from the belt, out of the sludge flow, while the unit is operating, to facilitate cleaning. The Manufacturer shall be required to demonstrate that individual plows shall be capable of allowing a 1/2 inch vertical obstruction on the belt to pass under them without deflecting and without damaging the equipment. A mechanical device, excluding cables, shall assist the raising and lowering of the furrowing devices. The rows of furrowing devices shall be capable of being secured in the upright position out of the flow of the sludge. The thickening zone shall have a minimum free drainage area of 88 square feet. No auxiliary vacuum shall be required.

The first dewatering section of the unit shall provide a wedge zone where the upper belt shall converge with the lower belt at an adjustable dewatering angle and generate continuously increasing pressure between both dewatering belts. The complete wedge zone framework, including wear bar support, shall be fabricated of 316L stainless steel. Side seals shall be provided, as necessary, to contain the sludge within the belts. The minimum effective filtration area in the wedge zone shall be 40 square feet. The effective dewatering area shall be calculated using both belts on either horizontal or vertical wedge zones.

The second dewatering section of the unit shall provide a compression zone where the upper and lower belts shall run in an S-roll configuration around a minimum of eight (8) rollers to provide the maximum possible cake dryness. The

upper and lower belts shall converge with the sludge cake between, and wrap around the rollers. The first roller in the compression zone shall be a perforated roller designed to allow water to escape out both ends. With belt tension constant, the sludge shall undergo an incremental increase in surface pressure as the belts wrap around each roll. Belt tension shall be adjustable during operation. The compression zone shall have a minimum drainage area of 120 square feet, calculated utilizing the area where both belts are in contact with a roller.

Facilities shall be provided to ensure correct belt tensioning and alignment. Water sprays shall be provided for cleaning the belts.

2-5. MATERIALS. The belt filter press(s) shall be constructed of materials meeting the following minimum requirements:

Welded Stainless Steel	AISI Type 316L.
Nonwelded Stainless Steel	AISI Type 316.
Steel	ASTM A36, SAE 1020, or equal; hot dipped galvanized after fabrication.
Cast Iron	ASTM A48.
Fiberglass Reinforced Plastic	
Resin	Polyester of a type suitable for the chemicals and conditions.
Reinforcement	Glass fiber with suitable coupling agent.
Plastic Laminate	Polyester or other suitable thermo-setting plastic reinforced with fiberglass.
Finished Thickness	Within ±10 percent of nominal.

2-5.01. Stainless Steel. All stainless steel shall be pickled at the mill in accordance with ASTM A380 before being shipped. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication, including welded areas, shall be repickled or passivated in accordance with ASTM A380 as required to remove all traces of iron

contamination. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2-6. BELT FILTER PRESS CONSTRUCTION.

2-6.01. Main Structural Frame. The main structural frame shall be constructed of wide flange members conservatively designed to minimize deflection. The main structural frame shall be constructed of members having a minimum thickness of 5/16 inch for hot dipped galvanized construction. The belt filter press frame shall provide a minimum safety factor under maximum load of five times the design yield strength of any member. All welds shall be continuous and ground smooth. The frame design shall allow easy access and visual contact with all internal components. All frame beams shall have a minimum moment of inertia of 53 in^4.

The main frame shall incorporate filtrate collection pans. The frame shall be provided with holes for foundation bolts and shall be provided with lifting eyes.

Layout and construction of the frame shall allow easy access to the operating components of the unit for observation, adjustment, and maintenance. Holes for all bolted connections shall be precisely drilled. Slotted holes will not be acceptable.

All hardware throughout the entire dewatering unit shall be of corrosion-resistant materials and shall include, but not be limited to, nuts, bolts, washers, cotter pins, adjustment screw rods, sidecover hardware, handles, and hinges. All hardware shall be stainless steel as a minimum.

2-6.02. Rolls. All rolls shall be of sturdy low deflection design.

Maximum deflection shall not exceed 0.05 inch at 50 pounds per linear inch belt tension and belt speed of 15 feet per minute to prolong bearing and roller life. All rolls shall have a minimum safety factor of four based on fatigue stress.
All rolls shall have through shafts or stub shafts with double end plate or journal construction to ensure structural integrity and reliability and minimize deflection and bearing wear. Rolls shall be mounted to accurately track the belts. All rolls, except the perforated roll, shall have a minimum wall thickness of 1/2 inch for carbon steel construction. The perforated roll shall have a minimum wall thickness of 3/16 inch and shall be of stainless steel construction. Concentricity of all rolls shall be within 0.01 inch.

All roll coatings shall be smooth and uniform to ensure accurate belt travel. All rolls, except perforated rolls, shall be coated. Drive rollers shall be coated with Buna-N rubber, 1/4 inch thick, and all other solid rollers shall be coated with Rilsan nylon to a minimum thickness of 25 mils. Rolls shall be coated up to the

point of insertion into the bearing block or shall have shafts and heads of stainless steel. Carbon steel roller surfaces shall not be exposed to sludge or moisture. Shafts in the pressure section shall be minimum 3.5 inch diameter at the bearing.

All rolls shall rotate in antifriction self-aligning bearings especially equipped with seals to prevent the entrance of water, sludge, and conditioning chemicals. Bearings shall have a minimum ABMA L_{10} rating without adjustment factor of 300,000 hours at the specified operating conditions. This ABMA L_{10} rating shall include all forces applied to the bearings, based on a belt tension of 50 pounds per linear inch, a belt speed of 15 feet per minute, and taking into consideration the roller mass forces and belt tension forces. Bearings shall not be located at points where they will be affected by stress in frame members. Bearings shall require lubrication at intervals no greater than 6 months.

Grease fittings shall be supplied to each bearing with remote stainless steel lines and shall be fastened to the exterior of the belt filter press frame as required to allow lubrication at accessible locations while the unit is operating. All bearing housings shall be split case pillow-block type, and shall have bearing overpressure relief. MANUFACTURER shall provide 5 year unconditional warranty on bearings.

2-7.03. Belts. The belts for the belt filter press shall be woven from polyester monofilament wires. There shall be no joint or overlapping thickness or hinged or seamed connection which would cause wear at the discharge doctor blades. Each belt filter shall be of the split type, and splicing devices shall have a tensile strength at least five times the maximum tension to which the belt is subjected. Subject to the review of the Design-Builder, the DSS shall select the belts which will best operate with the anticipated type of sludge and conditioning chemical. The selection of the belts shall be based on actual previous operating experience. Belts shall have heat sealed edges and shall be equipped with easily operated splices. The porosity of the splices shall not exceed the porosity of the belt. Endless/ seamless belts may be acceptable subject to Design-Builder's review.

Minimum belt life shall be 2,000 hours based on the specified service and design conditions. Belts that have failed prior to 2,000 hours shall be replaced with belts that will meet the specified requirements at no additional cost to the Owner.

Spare belts shall be identical to those provided on the unit unless the Owner or Design-Builder agree to a change.

2-7.04. Belt Discharge. Dewatered sludge cake shall be removed from the upper and lower belts by adjustable doctor blades. The doctor blade assembly shall be spring loaded or counterweighted. Springs and counterweights shall be manually adjustable. The doctor blades shall be HDPE or UHMW polyethylene.

The lower doctor blade shall also direct the dewatered sludge cake to the receiving screw conveyor as indicated on the Drawings.

2-7.05. Belt Washing System. A belt washing system shall be provided to effectively clean each belt.

Water will be supplied from the plant recycled water (PRW) supply at the location(s) shown on the Drawings. The spray wash water system shall be designed to provide the required water to the belt filter press system and shall be coordinated by the DSS. A spray water booster pump shall be provided for the press, if required. The pump shall be suitable for operation with chlorinated plant recycled water (MBR filtrate), shall be furnished by the DSS, and shall be as specified herein.

Belt cleaning shall be accomplished by water sprays. There shall be one belt spray assembly for each belt. The belt spray assembly shall be comprised of a header pipe equipped with flat recessed, spray nozzles and shall incorporate a wire brush cleaning system operated with a handwheel. The handwheel shall be easily accessible to allow nozzle cleaning during press operation.

All metal components of the belt shower assembly shall be constructed of stainless steel.

Wash water piping at least 1-1/2 inches in diameter shall be provided on the belt filter press. A strainer shall be supplied with a filter element perforated with openings equal to, or smaller than, those in the nozzles. The strainer shall be capable of being cleaned by opening a flushing valve connected to the strainer. A 3/4 inch threaded hose connection shall be provided with the flushing valve. A 1-1/2 inch solenoid valve with NEMA Type 4X enclosure, interlocked with the belt filter press, shall be provided for the wash water system supply line to the belt filter press. A pressure regulating valve to control the wash water pressure at the belt filter press shall be provided for each belt filter press if required by the system provided. A pressure gauge suitable for operation over the pressure range to be encountered with an isolation valve shall be provided for each belt filter press. A flow switch or pressure switch to sense loss of wash water flow or pressure shall be provided for each belt filter press. Switches shall have 10 ampere rated contacts at 120 volts and shall be wired to the belt filter press control panel. Circuit boards shall be provided with an anti-fungal coating. Flow switches shall be Fluid Components "Model 12-64" or equal. Pressure switches shall be Barksdale "Series 96211", SOR "Model 6NN-K3-C2A", or equal.

The belt spray operating assembly shall be housed in a stainless steel hood extending across the full width of the belt, and a matching water collection trough shall be provided beneath the spray head with the belt passing between the two pieces. This housing shall be incorporated to contain the spray around the belt filter press and to separate the belt wash flow from the filtrate into a separate drain connection. Spray drainage shall ultimately discharge into the floor drain located within the containment area below the press. The housing shall be constructed of stainless steel. Spray tubes and nozzles shall be stainless steel. Rubber or brush seals shall be provided to eliminate misting. No spray water or misting shall occur outside the unit.

2-7.06. Drain Pans. Drain pans shall be provided to collect all filtrate and wash water drainage. The pans shall be fabricated from Type 316L stainless steel with a minimum thickness of 14 gauge. Bolt holes shall be adequately reinforced to prevent cracking or shear failure. A lip at least 1 inch high shall be provided around the perimeter of each drain pan. External ribs, if required, shall be provided to reinforce the pan against distortion under the full hydrostatic load.

Each drain pan shall be provided with a drain line fabricated from solvent welded PVC pipes and conveyed to the floor drain indicated on the Drawings. The pipe shall be oversized to prevent clogging and shall be provided with cleanouts for rodding. Tees with screw plugs for cleanouts may be provided. Corrosion-resistant drain piping from the various troughs shall be drained to the concrete sump below the belt filter press.

The belt filter press and drain pans shall be designed to contain all sludge, drainage, filtrate, and spray water within the unit. If a vertical wedge is supplied a 316L stainless steel splash pan shall be provided to prevent splashing of liquid on to the backside of the filter belt of the pressure section.

2-7.07. Distribution Box. Sludge shall be contained in the gravity section by a stainless steel box-frame assembly with gaskets. Attached to the assembly shall be two parallel deckle strips or wedges to control the flow of sludge in the gravity section. Sludge shall be evenly distributed across the full width of the belt.

A proximity switch shall be provided in the distribution box to detect low or no sludge cake. The proximity switch shall have contacts rated 5 amps at 120 volt ac.

2-7.08. Belt Drive Unit. Each belt filter press shall be provided with a variable speed drive unit. Output speed regulation shall be as required for the Manufacturer's belt filter press. The drive unit shall be protected by corrosion-resistant coatings as a minimum.

Each motor shall comply with the General Equipment Stipulations except as specified herein. Each motor shall be rated 480 volts, three phase, 60 Hz, totally

enclosed fan cooled (TEFC), and corrosion-resistant with insulation systems sealed for moisture and mildew resistance.

Each motor shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heater shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for a 120 volt, 60 Hz, single phase power supply. The space heater shall be wired to the motor terminal box.

Each motor selected for adjustable speed control shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amperes at 120 volts ac. The contacts shall be wired in series with the end leads brought out to a separate motor terminal box. Switches shall be as recommended by the motor Manufacturer.

Motors shall be specifically selected for service with an variable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when operating in the installed condition at load with power received from the variable frequency drive. All motors used with drives shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

The belt drive shall be capable of varying its output speed from 50 to 150 percent of the speed required for the design conditions, without disassembly.

All gear reducer and motor bearings shall be oil or grease lubricated. All gears and chains shall run in oil or shall have a positive means of constant lubrication. Seals shall be provided to prevent oil leakage around shafts. Lubrication systems shall be protected against contamination and be designed so that the lubricants cannot contaminate the fluid being processed. Each lubrication system shall be provided with an external, visual method of checking lubricant level, without removing parts or fittings.

Lubrication shall be accomplished by means of oil fill and drain plugs or grease fittings which shall be convenient and accessible. Lubrication shall be accomplished without removing parts or dismantling equipment. Oil drains, fill openings, or grease fittings shall allow for convenient collection of oil in containers, either from the platform or from the ground, without removing the unit from its normal installed position.

A warning nameplate shall be provided on each motor to warn the operator to trip the main breaker prior to performing maintenance.

2-3.09. Variable Frequency Drives. The belt filter press shall be furnished complete with a variable frequency drive. The variable frequency drive shall be located in the main control panel and shall be coordinated with the requirements of the belt filter press drive unit. The VFD shall conform to the requirements listed in the Variable Frequency Drives section.

The DSS shall be responsible for furnishing the VFD(s) and for coordinating the VFD and drive components to ensure that a complete and properly operating system is furnished. All equipment shall be derated as recommended by the VFD and motor Manufacturers for reduced speed operation with an adjustable frequency controller in addition to any derating requirements specified elsewhere.

2-8. CORROSION PROTECTION. The belt filter press frame and all possible components shall be hot dip galvanized steel. All other surfaces shall be protected with a corrosion-protection system.

As a minimum, all surfaces that cannot be constructed of hot dip galvanized steel shall be protected by painting as specified herein. All surfaces to be painted shall be blast-cleaned in accordance with SSPC-SP10. All iron and steel surfaces shall be covered with one coat of zinc-rich epoxy primer, an intermediate coat of flat epoxy paint, and a final coat of gloss epoxy paint. The paint shall be as recommended by a single MANUFACTURER for the service intended and applied to provide a final dry film thickness of 10 mils minimum.

As a minimum, all prepainted purchased equipment such as electric motors shall be coated with a final gloss coat of epoxy paint to match the remainder of the unit. An appropriate seal coat over the factory finish shall be applied if recommended by the paint Manufacturer.

All fiberglass reinforced plastic surfaces shall be finished to a uniform color which shall be incorporated into the plastic resin.

Machined or polished ferrous surfaces such as pipe flanges shall be provided with a temporary protective coating of a nondrying oil type rust-preventive compound.

2-8.01. Correction Work. Any location where corrosion is identified by Design-Builder shall be considered a failure of the material or the protection system. Before starting correction work, the DSS shall submit to the Design-Builder for review an analysis of the cause of the failure and details of the proposed correction work. The DSS shall make repairs acceptable to the Owner at all points where failures are observed within the correction period.

2-8.02. Inspection. The belt filter press shall be inspected at the end of the correction period by the Design-Builder to identify any failures that may have

occurred. Scheduled inspections shall not relieve the DSS from the obligation to perform correction work whenever needed.

The DSS shall prepare and deliver to the Design-Builder an inspection report covering each inspection, indicating the number and type of failures observed, material and part where materials have failed, the percentage of the surface area where corrosion-protection system failure has occurred, and the names of the persons making the inspection. Color photographs illustrating each type of failure shall be included in the report.

2-9. SLUDGE CONDITIONING UNIT. The belt filter press shall include sludge conditioning equipment designed to efficiently mix the sludge with the polymer. The equipment shall consist of an in-line mixer as recommended by the manufacturer and accepted by Design-Builder. The conditioning equipment shall be designed to operate without plugging with sludge containing stringy material. A single sludge inlet connection and separate connection for the conditioning chemical shall be provided.

All parts contacting sludge or chemicals shall be Type 316 stainless steel or equivalent corrosion-resistant materials.

2-9.01. In-Line Mixer. An in-line non-clog venturi mixer designed to efficiently mix the sludge with the polymer shall be provided for the new belt filter press. The mixer shall be recommended by the DSS and accepted by Design-Builder. The mixer shall be designed to operate without plugging with a combined sludge containing stringy material. A single sludge inlet connection and separate connection for the conditioning chemical shall be provided.

All parts contacting sludge or chemicals shall be stainless steel or equivalent corrosion-resistant materials.

The mixer system shall provide the following performance:

a. Energy for mixing polymer and sludge shall be adjustable while the belt filter press is operating.

b. The polymer and sludge must be instantaneously mixed by the mixer system.

c. The flocculation time shall be adjustable by changing the location of the mixer using the alternate mixer locations. Up to three alternate mixer locations will be provided with input from the DSS as to these locations.

d. Adjustment of mixing energy shall be independently adjustable.

The mixer shall be equipped with a vortex polymer injection ring with tangentially mounted polymer injectors. The mixer shall be located in the sludge feed line upstream of the belt filter press. The DSS shall be responsible for the proper layout of the system. Open throat area shall be as recommended by the DSS, and the open area shall be infinitely adjustable downward with the auxiliary mixing device. Elbows, bends, modified check valves, or special pipe sections will not be considered an acceptable substitute for the specified venturi mixer.

2-10. BELT ALIGNMENT/TENSIONING SYSTEM.

2-10.01. Belt Alignment. Each belt shall be automatically aligned by a pressure-sensitive belt guidance system. The system shall operate hydraulically and require no further attention or adjustment.

The belt aligning devices shall be hydraulically operated and designed to align each belt and locate it centrally on the roller by means of a sensor which detects the position of the belt edge. The sensor shall operate a pilot valve which in turn affects the position of a hydraulic / pneumatic actuator connected to a pivoted belt alignment roller, causing this roller to skew from its transverse position. The alignment systems shall function as a continuous automatic belt guidance system and shall be an integral part of the belt filter press. The alignment system shall operate with smooth and slow motions resulting in a minimum of belt travel from side to side. The use of electrical servos or similar devices will not be acceptable. A system utilizing a hydraulic cylinder which maintains alignment by a large snap action type alternating movement from the fully closed to the fully extended position of the cylinder will not be acceptable.

In addition, electric limit switches shall be provided to signal belt misalignment (alarm) and gross belt misalignment to automatically stop each unit when necessary.

2-10.02. Belt Tension. Belt tension shall be automatically maintained hydraulically to prevent belt damage while providing adequate pressure for dewatering. The system shall automatically adjust for various cake thicknesses to maintain a constant pressure.

Increasing belt tension shall result in a spontaneous increase in dewatering pressure applied in the high pressure section. Belt tensioning shall ensure even surface pressure in the compression section and shall guarantee proper belt alignment during change in belt tensioning. Separate controls shall be provided for the upper and lower dewatering and gravity section belts to allow independent shutoff for each belt. Belt tension shall be variable up to 50 pounds per linear inch and shall be adjustable without shutdown of the unit. Breast rolls shall have parallel movement. The system shall include a 316L stainless steel rack and pinion assembly to assure movement of thrust arms.

2-10.03. Hydraulic Power Unit. Each belt filter press shall be provided with a hydraulic power unit if required by the MANUFACTURER when hydraulic control of belt alignment and belt tensioning is provided. The hydraulic unit shall be a self-contained unit consisting of an oil reservoir fabricated of 316L stainless steel with a pump, electric motor, pump suction oil filter, and a master pressure regulator. The unit shall be provided with two flexible hoses of sufficient length to connect to the belt filter press. The hydraulic power unit shall be powered from the belt filter main control panel. The belt filter press main control panel shall include the starter and required controls and safety interlocks. A low pressure switch shall be wired to the control panel to indicate low hydraulic pressure. A high pressure switch shall be provided to shut down the unit and provide an alarm at the control panel.

The pump, motor, reservoir, oil filter, and valves shall be mounted on the belt filter press frame on the drive motor side. The reservoir shall be of translucent HDPE to allow visual inspection of the oil level. The pump motor shall be 1 horsepower, 1,200 rpm, 480 volts, three phase, NEMA B design with a "C" face mounting for the hydraulic pump adapter. The hydraulic filter shall be of the reusable, washable screen type, with a nominal rating of 10 microns.

All hydraulic lines shall be AISI Type 316 stainless steel as a minimum, and shall be rigidly supported on the structural frame.

2-11. SPRAY WATER BOOSTER PUMPS. Each belt filter press requiring a booster pump shall be provided with a single-stage, centrifugal, close-coupled, vertical, in-line pumping unit, designated as a water booster pump, shall be provided as a part of each belt filter press system. The DSS shall be responsible for coordinating the water booster pumps with each belt filter press.

Each pumping unit shall be securely supported and shall be complete with pump, electric motor, and all other appurtenances that are specified or required for proper operation. A spare mechanical seal shall be furnished with each pumping unit.

2-11.01. Pumping Units. Pumping units shall be designed to provide sufficient flow at the required head to meet the wash water requirements of each belt filter press.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction pressures. The design performance shall be based on a wearing ring diametral clearance of not less than 0.012 inch, or 1 mil per inch of wearing ring diameter, whichever is greater.

2-11.02. Pump Materials. Each pump shall be bronze fitted, using materials as listed below:

Casing	Cast iron, ASTM 48.
Casing Wearing Ring	Cast iron, ASTM 48; or bronze, ASTM B62.
Impeller	Bronze, ASTM B62.
Shaft	Carbon steel.
Shaft Sleeve	Bronze, ASTM B144, Alloy 937; or AISI 416 stainless steel.
Stuffing Box Hardware	Noncorrosive metal.
Mechanical Seal	Durametallic "Type RO", Chesterton "Style 880", or John Crane "Type 21".
Base	Cast iron or fabricated steel.

The casing shall permit the removal of the rotating element without disconnecting the piping. Registered fit between casing parts shall maintain alignment. The nozzles shall have ANSI 125 lb flange and drilling.

A bypass line shall be provided for the mechanical seal between the seal faces and the suction flange to vent the seal chamber and to provide lubrication.

Pipe tapped openings shall be provided for draining and venting the casing.

Impellers shall be enclosed type, shall be one-piece castings completely machined on all exterior surfaces, and shall be dynamically balanced. The interior water passages shall have uniform sections, smooth surfaces, and be free from cracks and porosity.

Impellers shall be keyed to the shaft and positively held in the center of the discharge volute.

Pump shafts shall be completely machined and large enough to hold shaft deflection at the seal to less than 0.002 inch at all operating heads.

The shaft shall be provided with sleeves extending from the impeller through each stuffing box. Each sleeve shall be positively locked against rotation and axial movement and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly on the shaft, total runout shall not exceed 0.002 inch.

Renewable wearing rings shall be provided in the casing. Design running clearance shall be not less than 1 mil per inch of ring diameter. The casing ring shall be positively locked against rotation.

Each stuffing box shall contain a mechanical seal as specified in the materials list. A flushing connection shall be located at the normal position of the lantern ring.

Each pumping unit shall be provided with lifting eyebolts or lugs, plugged gage cock connections at the suction and discharge flanges, and tapped and plugged openings for casing and bearing housing vents and drains. Flushing water connections to mechanical seals shall be equipped with 25 micron reusable, ceramic filters.

2-11.03. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the vibration displacement (peak-to-peak) as measured at any point on the machine shall not exceed 2.0 mils.
At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

2-11.04. Electric Motors (Spray Water Pump). Motors, including bearings, shall be self-air-cooled and grease or oil lubricated. Motors shall have antifriction bearings with an ABMA minimum L_{10} life rating of 40,000 hours when carrying the maximum pump load within the specified operating head range. The motors shall be vertical solid shaft as required.

Each motor shall comply with the General Equipment Stipulations except as specified herein. Each motor shall be rated 480 volts, three phase, 60 Hz, totally enclosed fan cooled (TEFC), and corrosion-resistant with insulation systems sealed for moisture and mildew resistance.

Each motor shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heater shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for a 120 volt, 60 Hz, single phase power supply. The space heater shall be wired to the motor terminal box.

Bearings shall withstand maximum upthrust from the pump. Bearings shall have overgreasing prevention or oil level indication. Bearings and lubricant identities shall be engraved on nameplates. Motor air gaps shall be treated to resist rust in a moist atmosphere below 20 ^{0}C. Motor shafts shall be designed for direct pump impeller attachment and rigid impeller support.

2-11.05. Installation. Each pumping unit shall be leveled, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump Manufacturer, the Hydraulic Institute Standards, and as required herein.

Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit. Shimming between machined surfaces will not be permitted.

2-12. OBSERVATION PLATFORM. An observation platform and stairs for access to the platform shall be provided to provide ease of access and maintenance for the facility. All components of the platform, including grating, handrail, supports, and stairs shall meet CalOSHA requirements and shall be constructed of aluminum meeting the requirements of the structural and miscellaneous metals section. All assembly and anchor bolts shall be stainless steel. The maximum elevation of the platform shall be such that the difference in elevation from the top of platform to the top of the belt for the independent gravity zone is less than 40 inches and not more than 24 inches. If the difference in elevation from the top of the filtrate containment curb to the top of the independent gravity zone is less than 40 inches, an observation platform shall only be provided if required by the Manufacturer.

The platform shall be freestanding. The platform shall form a clear walkway at least 42 inches wide, shall be floored with minimum 1-1/4 inch grating, and shall be diagonally braced against lateral movement. Bracing shall be designed to provide for any piping arrangement shown on the Drawings. The walkway shall be designed and constructed so that any deflection will not exceed 1/300 of the span length under consideration considering all dead loads plus a live load of 200 pounds per square foot on the platform. The walkway shall be in accordance with the Seismic and Meteorological Design Criteria specification.

Three-rail railings 3'-6" high shall be provided along each side of the platform and stair. Railings shall be aluminum as specified in the structural and miscellaneous metals section and as shown on the Drawings. A kickplate at least 4 inches high shall be provided around the entire platform.

The platform shall be provided with the necessary brackets and mounting plates for supporting the electrical conduits and control panels.

2-13. ELECTRICAL. The electrical drawings indicate the anticipated electrical power, control, and instrumentation equipment required for a typical belt filter press. The supplier shall be responsible for supplying and installing any additional equipment, cable, conduit, devices, and controls required or

recommended by the DSS for the safe and satisfactory operation and supervision of the belt filter press and related equipment actually provided.

The belt filter press units shall be prewired to the extent possible with all electrical connections being brought to two (2) junctions boxes as described herein.

2-13.01. 480 Volt Power Terminal Box. All 480 volt power connections for motors and power devices provided with the belt filter press shall be provided prewired to a NEMA Type 4X 316 stainless steel terminal box on the belt filter press assembly. All terminals shall be of the copper compression type suitable for the wire sizes indicated on the Drawings or as determined to be required by the DSS. All terminals shall be permanently labeled as to device, terminal number, and voltage.

All wiring from the respective devices on the belt filter press to the 480 volt terminal box shall be in PVC-coated galvanized steel conduit as specified in Section 16050 of these specifications.

2-13.02. 120 Volt Control Terminal Box. All 120 volt and below instrumentation and control devices provided with the belt filter press shall be provided prewired to a NEMA Type 4X 316 stainless steel terminal box on the belt filter press assembly. All terminals shall be of the copper compression type suitable for the wire sizes indicated on the Drawings or as determined to be required by the DSS. All terminals shall be permanently labeled as to device, terminal number, and voltage.

All wiring from the respective devices on the belt filter press to the 120 volt terminal box shall be in PVC-coated galvanized steel conduit as specified in Section 16050 of these specifications.

2-13.03. Controls. The sludge handling system shall be furnished with a Local Control Panel to control the operations of the belt filter press unit and the associated sludge pumping and conditioning equipment.

2-13.03.01. Programmable Logic Controller. Programmable logic controllers (PLCs) shall be provided for control and sequencing of unit operations. PLCs shall conform to the Programmable Logic Controllers section and shall be factory programmed for the operator-initiated automatic startup and shutdown of the system as described herein and in the Programmable Logic Controllers section.

2-13.03.02. Belt Filter Press Local Control Panel. Each Belt Filter Press (BFP) and its associated equipment shall be controlled from its respective individual BFP Local Control Panel. Local control panels shall be provided with a PLC and an operator interface terminal (OIT) which meet the requirements specified in the Programmable Logic Controllers section. Although described as physical

devices from hereon, control and indicating devices may be physical switches, pushbuttons, and indicating lights wired to the local PLC or OIT graphics with interface through the OIT touch screen and/or keypad. Each local control panel shall include a system "LOCAL-OFF-AUTO" switch. In the "LOCAL" position, the system shall be controlled by individual "ON-OFF" selector switches or pushbuttons on the local control panel for the following equipment and speed control devices where appropriate. In “AUTO,” the system will start and stop the following equipment automatically:

a. Belt Drive.
b. Belt Tensioning/Alignment System.
c. Bet Speed.
d. Spray Water Pump (if applicable).
e. Spray Water Valve.
f. Discharge Screw Conveyor(s) (if applicable)

The controls shall be provided on the local control panel for the following equipment as specified herein.

a. Belt Filter Press Sludge Feed Pump.
b. Polymer Feeder Blender.

"Run" and "Stop" indicating lights shall be provided on the local control panel for the belt drive, tensioning/alignment system, spray water pump, and hydraulic power unit. "Open" and "Close" indicating lights shall be provided on the local control panel for the spray water valve.

A red "mushroom head" push button shall be provided on the main control panel for emergency stop of the belt filter press system.

The local control panel shall provide an Ethernet signal to the Plant Control System (PCS) for remote belt filter press system shutdown alarm and system running.

The local control panel shall control the spray water valve as required to ensure the valve is open when the press is running. The local control panel shall provide suitable time delays on alarms as required to allow for equipment startup. The local control panel shall provide individual alarm lights for each BFP system alarm.

Each belt filter press shall be provided with instruments and controls to provide the following minimum alarms to the Belt Filter Press Local Control Panel:

a. Belt Tensioning/Alignment System Fail (Low and High, Air, or Hydraulic Pressure).
b. Belt Misalignment.

c. Gross Belt Misalignment (Shutdown).
d. Emergency Stop Actuated (Emergency Stop Switch).
e. Belt Breakage (Shutdown).
f. No Sludge Flow.
g. Loss of Water Pressure (Downstream of Spray Water Valve).
h. Drive Unit Fail.
i. Hydraulic Power Unit Fail. (Shutdown)

Each belt filter press shall be provided with the following control equipment for controlling equipment remote from the belt filter press unit: "START-STOP" push buttons for the associated Dewatering Sludge Feed pumps (DWT-P) and polymer feeder blender (PFB), sludge flow digital panel indicators, polymer feed rate digital panel indicators, belt speed digital panel indicators, speed potentiometers for the associated Dewatering Sludge Feed pump, polymer feeder blender, and belt speed control, and red "Mushroom Head" emergency stop push button. The local control panels shall be a NEMA Type 4X 316 stainless steel enclosure which meets the requirements of the Panels, Consoles and Appurtenances section.

72-DWT-BFPS-0001 local control panel shall include the "START-STOP" push buttons and speed potentiometers and indicating lights for polymer feeder blenders in accordance with the Panel Mounted Instruments section.

Digital indicators shall be provided in accordance with the Panel Mounted Instruments section.

The local control panels shall be provided with electronic signal booster/isolators as required. Electronic signal boosters and isolators shall be provided in accordance with the Panel Mounted Instruments section.

The dewatering system supplier shall coordinate all necessary outputs with the supplier of the polymer feed system and the sludge feed pumps.

2-13.03.04. Emergency Stop Switch. Each belt filter press shall be equipped with an emergency stop safety switch with two normally closed double break contacts. Contacts shall be manually reset. Switches shall be equipped with a latching mechanism and a weight and cable for operation of the switch. Switches shall be opened by cable linkage mounted on all sides of the respective belt filter press frame. Cables shall be plastic covered metal cable (blaze orange color) and shall be located along the belt filter press frame within easy reach of operating personnel who may be maintaining or observing the operating belt filter press.

The switch shall be furnished with standard watertight covered terminal trip junction box 1/2 inch threaded conduit connection. Each switch shall be furnished and mounted as an integral part of the belt filter press framework.

Each switch shall have a 10 amp, 115/120 volt ac rating. Switches shall be Clark Controller Co., G. E. Company, or equal, with appropriate enclosure. Action of the emergency safety switch shall immediately deactivate the belt filter press drive and accessories.

2-13.03.05. Variable Frequency Drives. Each variable frequency drive shall be coordinated with the requirements of the driven equipment. Particular attention shall be directed toward the driven equipment torque requirements.

The BFP supplier shall be responsible for coordinating the VFD with the driven equipment to assure compatibility between the drive and motor. All equipment shall be derated as recommended by the VFD and motor manufacturers for reduced speed operation with an variable frequency controller in addition to any derating requirements specified elsewhere.

Each VFD shall be pulse-width modulated type and shall produce an adjustable ac voltage/frequency output. Each VFD shall maintain a minimum displacement power factor of 0.95 over the entire speed range, and shall be equipped with an

output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

Each VFD shall be equipped with an input line reactor and a full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor which generates a sine-coded output voltage.

The VFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. Each VFD shall be configurable for automatic and manual reset and shall have an adjustable carrier frequency to at least 6000 Hz.

VFDs shall be manufactured by Allen-Bradley, Square D, Toshiba, or approved equal.

2-13.03.06. Panel Devices. Selector switches, indicating lights, and push buttons shall be heavy-duty, oiltight, push-button station type with contacts rated 10 amperes at 120 volts ac and shall have engraved or etched nameplates identifying application and each switch action. Indicating lights shall be LED push-to-test type.

Auxiliary and time delay relays shall be heavy-duty, industrial type, with 120 volt ac coil and output contacts rated 10 amperes at 120 volts ac. Time meters shall be synchronous motor drive, 99,999.9 hours span, non-reset, and 120 volts ac.

The devices on the local control panel shall be rated NEMA type 4X.

2-13.03.07. Power and Control Wiring. The control panels shall be completely wired with provisions for terminating all remote wiring on terminal blocks. The terminal blocks shall be marked to agree with the MANUFACTURER's wiring diagram. Control terminal blocks shall be sized for No. 12 AWG copper wire. All interconnecting wiring and wiring to terminals for external connection shall be not less than No. 14 AWG copper, insulated for not less than 600 volts with a moisture and heat-resistant material and flame-retardant nonmetallic covering. All wiring shall be grouped or cabled and firmly supported to the panel. Not less than 25 percent spares shall be provided.

All devices within the panel shall be permanently identified. Nameplates shall be provided on the face of the panel or on the individual device as required. Nameplates shall be made of laminated phenolic material. All wires shall be numbered at each termination with permanent labels corresponding to the schematic.

2-14. SHOP TESTING. The belt filter press shall be tested in the Manufacturer's shop for mechanical performance. This shall include operating to check alignment, test for faulty equipment and controls, proper wiring, and proper operation of safety and operating controls. A statement from the DSS certifying that the specified shop test has been performed shall be submitted to the Design-Builder prior to shipment.

PART 3 – EXECUTION

3-1. INSTALLATION. Each unit shall be installed in accordance with Equipment Installation section and as specified herein.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the Manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The Manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily and in accordance with the specified performance requirements.

All pre-checks and preliminary tests will need to be completed and approved by the Design-Builder and Manufacturer prior to performance testing.

All costs for these services shall be included in the contract price.

3-3. PERFORMANCE TEST. The performance tests shall be conducted by a capable representative of the Manufacturer and accepted by Design-Builder. All costs for these services shall be included in the contract price.

Owner's operating personnel will assist the Manufacturer's representative in the performance test. A designated representative of Design-Builder will observe the performance tests.

Preliminary performance tests shall be conducted using the equipment under the design conditions specified. Once the appropriate operation parameters are established, extended duration performance tests shall be conducted to demonstrate the equipment's ability to consistently perform at the design conditions specified.

The test results will be used to prove compliance with the performance requirements prior to acceptance of the equipment. Consistent compliance with design conditions shall be defined as the average of sample values meeting or exceeding the specified design conditions.

The equipment Manufacturer shall detail the proposed field evaluation and performance testing procedures and analyses, subject to approval by Design-Builder. If more than one day of testing is required, the testing shall be done on consecutive days.

3-3.01. Field Evaluation Tests. The Design-Builder shall perform field evaluation tests of each belt filter press system to demonstrate that the equipment complies with the design conditions specified herein. A minimum of 30 days prior to the testing, the Manufacturer shall perform, at the Manufacturer’s expense, the necessary testing to determine the type and dosage of polymer required to meet performance requirements. The results of the polymer evaluation along with the recommendations for the type of polymer and optimum dosage shall be provided to Design-Builder. The Manufacturer shall be solely responsible for the polymer dosage used in the belt filter press testing. The tests shall be run at a time acceptable to the Design-Builder. The equipment Manufacturer's representative

and the Design-Builder shall witness the tests. Design-Builder shall initial all data collection sheets.

At least two weeks prior to testing, the DSS shall prepare a schedule for field evaluations and written testing procedures and submit to the Design-Builder. Proposed data collection sheets and calculation formulas shall be included.

Preliminary field tests shall be conducted using each belt filter press under the design conditions specified. Preliminary field tests shall consist of a series of runs to determine the appropriate belt speed, pressure, and liquid polymer dosage to meet the design conditions. It is the Manufacturer's responsibility to verify calibration of polymer feed equipment feed rates prior to the performance test.

Once the appropriate parameters are established, extended duration field tests shall be conducted to demonstrate the equipment's ability to consistently perform at the design conditions specified. Each belt filter press shall be operated for a minimum of 4 consecutive hours under the design operating conditions. The Manufacturer's representative shall adjust each belt filter press system at the start of each run and may make further adjustments hourly during each test run. Samples shall be collected at least every 30 minutes to determine sludge feed consistency, solids capture efficiency, and sludge cake moisture content. Consistent compliance with design conditions shall be defined as the average of sample values meeting or exceeding the specified design conditions during the testing period.

Samples will be collected by Design-Builder, and analyses shall be performed by a certified independent testing laboratory. On-site solids analysis may be used for guidance before and during the test; however, only certified lab analyses will be considered for compliance with the specified performance.

3-4. TEST REPORTS. The equipment Manufacturer shall prepare a test report, including all installation check and performance tests and other recorded data and observations. A PDF copy of the report shall be submitted to Design-Builder after completion of the specified tests.

3-5. MODIFICATIONS. If the system equipment fails to satisfy the performance requirements, the equipment shall be modified. Modifications shall be made, or additional equipment shall be furnished and installed, as necessary to produce an installation satisfying the performance requirements. The equipment shall be completely retested after modification. Modifications and additional equipment shall be provided, and retesting shall be performed at the expense of the equipment Manufacturer. All structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made at equipment Manufacturer's expense.

3-6. TRAINING. The equipment Manufacturer shall furnish the services of a competent and experienced operator of the equipment who is directly employed by the Manufacturer to instruct Owner's operating personnel in the proper operation and maintenance of the equipment. Training shall be in accordance with the Demonstration and Training section. All costs for these services shall be included in the Contract Price.

3-6.01. Operations Training. Classroom instruction covering the theory of operation, site specific operation of the equipment and optimization of the submersible propeller mixer operation.

3-6.02. Maintenance Training. Hands-on training in separate sessions for: (1) mechanical maintenance and (2) electrical and instrumentation maintenance. Sessions shall run concurrently following the operations training.

End of Section

Section 46 76 22

CALCITE CONTACTORS

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing of a complete calcite contactor system, including all necessary equipment and accessories. The complete calcite contactor system shall be provided by a single Calcite System Supplier (CSS). The vessels and pumps shall be as follows:

Number of Calcite Contactors	2
Calcite Contactor Equipment Tags	61-CAL-FLT-0101 61-CAL-FLT-0201
Number of Backwash/Flush Pump	1
Backwash/Flush Pumps Equipment Tag	61-CAL-P-001

Principal items to be furnished and installed by the CSS shall include the following:

- Two pressure vessels with valving.
- Internal vessel piping.
- Valve supports mounted on a skid.
- Filter Media (gravel support and calcite).
- Backwash/flush pump.
- Flush water control valves.
- System piping, valves, and instrumentation.
- Local Control Panel with VFD for the backwash/flush pump.

1-2. GENERAL REQUIREMENTS. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the CSS and individual equipment manufacturers unless exceptions are noted by the Design-Builder. The specified information does not relieve the CSS of the responsibility to provide a fully-functional system.

1-2.01. General Equipment Stipulations. Reference the General Equipment Stipulations section for equipment requirements, including but not limited to:

- Coordination
- Manufacturer's Experience
- Workmanship and Materials
- Structural Design Requirements
- Lubrication

- Elevation
- Electric Motors
- Drive Units
- Safety Guards
- Anchorage and Anchor Bolts
- Equipment Bases
- Special Tools and Accessories
- Shop Painting and Coating
- Labeling and Tagging
- Preparation for Shipment
- Storage
- Installation and Operation
- Observation of Performance Tests
- Programming Software

1-1.01. Identification. Contactor vessels specified herein shall be tagged in accordance with the P&IDs and as specified herein.

1-1.02. Seismic Design Requirements. Equipment and items furnished as specified herein shall be designed for installation and anchorage in a seismically active area in accordance with in Meteorological and Seismic Design Criteria section.

1-1.03. Painting and Coating Requirements. Equipment and items furnished as specified herein shall be furnished with shop coatings suitable for permanent installation and operation in accordance with the requirements in the General Equipment Stipulations section.

1-2. QUALITY ASSURANCE.

1-2.01. Reference Standards.

- American National Standards Institute (ANSI).
- American Society of Mechanical Engineers (ASME).
- American Society for Testing Materials (ASTM).
- American Water Works Association (AWWA).
- Confinement of Substances Hazardous to Health (COSHH).
- Institute of Electrical and Electronics Engineers (IEEE).
- International Standards Organization (ISO).
- National Electrical Code (NEC).
- National Electrical Manufacturers Association (NEMA).
- National Institute of Occupational Safety & Health (NIOSH).

- Occupational Safety and Health Administration (OSHA).
- Water Environment Federation (WEF)
- Commonwealth of Virginia Drinking Water Regulations
- U.S. Food and Drug Administration (FDA)
- National Sanitation Foundation (NSF)

1-2.02. Factory Acceptance Test (FAT). The CSS shall certify the piping hydrostatic pressure test passed:

System hydrotest administered at maximum working pressure for a period of 60 minutes with no leaks observed.

The CSS shall certify the Function Test passed:

Automatic system valves and components are in their correct positions during all cycles of operation.

Instruments have been calibrated and their readings have been verified against known control values.

System dimensions match submittal drawings.

CSS is to notify Design Builder and Owner 14 days before start of FAT to allow for scheduling of on-site verification of testing.

1-3. SUBMITTALS. In addition to the information/data required per the contract, the MSS shall provide the remaining submittals in accordance with the requirements specified herein and the Schedule of Submittals section. The Bid Submittals shall also be as detailed in the Schedule of Submittals section.

1-3.01. System Description Documents. Submit for review/approval the following in one comprehensive submittal package:

Complete design report including description of technology and system operation, mineralization process and its expected performance, any required chemical addition, description and location of valves and instruments, flows, and other required technical information required to describe a fully-functioning system.

Complete Equipment Scope of Supply for a fully functioning system.

Manufacturer's literature, cut sheets, illustrations, specifications, and engineering data, including dimensions, materials, size, weight, and

performance data for all components including valves, instruments, pumps, and other ancillary equipment.

Project schedule indicating submittals, equipment delivery, installation, and start-up dates.

1-3.02. Shop Drawings. Submit for review/approval the following in one comprehensive submittal package:

Design drawings shall include, but not be limited to the following:

a. General Arrangement (GA) drawings showing general dimensions, connections, elevations and overall system configuration. Identify materials, surface preparation, and finishes.

b. Process Flow (PFD) and Process & Instrumentation Diagrams (PID) showing the general process, valves and instruments used to control and monitor the system.

c. Applicable certifications and ratings.

d. Structural and seismic calculations for calcite contactor vessels. Include calculations for reactions at anchor bolts and selection of the size depth and number of bolts required for use with Simpson Set Epoxy anchor system.

e. Shop inspection schedule.

f. Bill of materials, weights (dry and operating), size, and location of all anchor bolts and nuts, and plan view system drawing.

g. Verification of ASME code design to include calculated head and shell thicknesses. Calculations shall be submitted with the first submittal drawing and be approved by the Design Builder prior to authorization of fabrication. Vessels shall be fabricated in a facility holding a current ASME U-stamp. Facilities holding an ASME R (“repair”) or other certification shall not be considered acceptable for vessel fabrication.

h. Pressure test reports and certificates of inspection for the vessel in accordance with procedures for ASME pressure rating and ASME Boiler and Pressure Vessel Code. Reports shall be furnished not later than the time of delivery of the vessels.

i. Motors

Name of manufacturer.

Type and model.

Type of bearings and lubrication.

Rated size of motor, hp.

Temperature rating.

Full load rotative speed.

Net weight.

Efficiency at full load and rated pump condition.

Full load current.

Locked rotor current.

j. Power/Control Panel and Components

VFD Name of manufacturer.

VFD Type and model.

Dimensions and net weight of complete panel.

Overcurrent characteristics and details of motor control.

Power and control wiring diagram

Schematic diagram

Power and control panel dimension and layout drawings

1-3.03. Operation & Maintenance Manuals. The CSS shall furnish complete O&M manuals to install, operate, maintain, and lubricate each component of mechanical and electrical equipment. The manuals shall comply with the requirements described in the Submittal Procedures section.

1-3.04. Training Materials. Training materials shall be provided per the Demonstration and Training section.

1-3.05. Spare Parts. The CSS shall provide spare parts per the general Terms and Conditions. The following shall be provided as a minimum:

- Any special tools required for installation or maintenance of any of the furnished equipment shall be furnished.
- A complete itemized price list of all recommended special tools, spare parts, and consumables shall be submitted.
- A set of recommended spare parts and consumables for system startup and testing shall be furnished.
- A set of recommended spare parts and consumables for one year of operation from Date of Substantial Completion or Acceptance of Final Testing, whichever is later, shall be furnished.

1-4. DELIVERY, HANDLING, AND STORAGE. The CSS shall coordinate with the Design-Builder and shall deliver the membranes for tank installation in accordance with the general Terms and Conditions of this procurement package.

1-5. MANUFACTURERS. One of the following manufacturers or equal:

Wigen Water Technologies - http://www.wigen.com/
Tonka Water - http://www.tonkawater.com/
Wagner Plate Works - http://www.wagnerplateworks.com/

1-6. WARRANTY. All equipment provided by CSS shall be free from defects in workmanship, design and materials for a 1 year period.

1-6.01. Finished Water Performance Warranty: During start-up, the equipment manufacturer's representative shall perform raw water and treated effluent field tests to confirm performance of the equipment. Analytical methods employed for field testing shall be performed by a digital colorimeter. Color comparators are unacceptable.

The equipment shall be warranted for a period of one year from the date of placing it on-line. The treatment water effluent during this period of time shall be as detailed in this Specification.

Sampling for conformance shall be taken during following one hour of operation after calcite flushing and placement into operation.

PART 2 - PRODUCTS

2-1. MATERIALS/EQUIPMENT

All components of the system herein described shall be fabricated and manufactured from new, unused materials, free from defects, of the highest quality possible.

2-2. CALCITE CONTACTORS. Calcite contactors shall consist of a vessel with flanged connections and internals for water and air distribution. Calcite contactor media shall consist of limestone media supported by a bed of gravel. Calcite contactors shall be furnished in accordance with the following filter design and performance requirements.

2-2.01. Design Requirements. The calcite contactor equipment shall be designed for the requirements listed in the Equipment Schedule.

2-2.02. Effluent Water Quality Requirements. The Calcite Contactors shall be capable of achieving the following effluent water quality objectives.

Parameter	Value
Alkalinity as $CaCO_3$, mg/L	40 - 60 mg/L as CaCO3
TDS	50-100 mg/L
LSI	<0

2-3. DETAILS OF CONSTRUCTION

2-3.01. Vessel.

All pressure vessels shall conform to the Equipment Schedule and be constructed in accordance with Section VIII of the ASME code requirements for cold fired pressure vessels, and shall bear the ASME stamp. Minimum thicknesses shall be furnished in accordance with ASME code requirements.

All flanges, plates, angles, channels, beams, etc., including sideshell to head connections, shall be joined by full penetration welds, each side, continuous welding. Flanges shall be factory welded on split centers prior to shipment.

The vessel, support structure, and all other shop assembled appurtenances of the system module shall be reinforced and supported with structural members as required such that the assembled components can be transported and off-loaded without distortion. The components shall be provided with lifting lugs to enable setting the equipment on a concrete foundation with a suitable capacity crane.

System supports shall be designed and drilled for installation and anchoring to concrete slab. Structural components shall conform to ASTM A 36 specifications.

2-3.02. Vessel Interior Construction.

- Effluent Collection System

  Each contactor vessel shall include a header/lateral collection system, factory installed prior to shipment.

  Effluent collection laterals shall be constructed of Schedule 80 PVC. All mounting hardware shall be stainless steel.

  Pipe collectors with submerged or semi-submerged orifice collection points shall not be acceptable due to the inherent plugging.

- Lower Flow Distributor System

A header-lateral inlet lower flow distributor system shall be installed in the contactor vessels. It shall be designed to insure uniformity of flow through the filter in both the backwash and treatment modes of operation. The flow distributor systems shall be of Sch. 80 PVC pipe construction and shall be structurally supported. The laterals shall be provided with openings to accept the flow diffuser nozzles. The header lateral flow distributor shall be constructed of Schedule 80 PVC with all joints solvent welded. No threaded joints will be allowed.

The lower head area of the filter shall be sandblasted and finish painted the same as the interior of the vessel above the underdrain.

The distributor diffuser nozzles shall be non-metallic, self-cleaning nozzles. Nozzles shall be provided with peripheral slot openings as required to collect and distribute flow laterally. Slot openings shall be tapered inward to prevent lodging of support gravel in the slot opening. Toggle-bolted designs are not permitted due to their inherent loosening potential. Diffuser nozzles using parallel metal or plastic plates, spacers and coupling bolts shall not be acceptable due to their “dead spot” characteristics and inability to uniformly collect and distribute flow laterally.

2-3.03. Vessel Miscellaneous Components.

Each vessel shall be equipped with one 14” x 18” manway, rated for the working pressure of the vessel. Manways shall be placed near the top of the vessel for access into the contactor vessel for purposes of gravel and calcite loading. Hatches shall provide a watertight and pressure tight seal.

Sample taps that are 1/2” diameter, full couplings shall be provided as described in the Equipment Schedule.

System shall be designed with multiple vessels or an isolated cell design to allow a portion of the system to be taken out of service at any time while still allowing treatment with the membrane system.

Structural steel saddles shall be provided for support of the vessels. Anchor bolts and calculations shall be supplied by the CSS in accordance with the Anchorage in Concrete and Masonry Section.

Pipe nozzles shall be of the size as shown on the Equipment Schedule and Drawings and shall consist of Sch. 40 steel pipe, projecting and terminating in a flange 6” from the outside face of the sideshell. Flanges shall be standard ANSI pattern, welded on split centers and shall be true and plumb.

2-3.04. Support Gravels and Media

The gravel shall be free of shale, mica, clay, sand, dirt and organic impurities.

The bottom layer of the screened support gravel shall be placed by hand to avoid damage to the diffuser assemblies. Each layer shall be placed and leveled before the addition of the next layer is started.

The calcite shall be placed on top of the support gravel and shall consist of the material, size and uniformity coefficient as shown on the attached Equipment Schedule. In addition, the calcite media shall be readily available in the local market.

The support gravels shall be procured from a manufacturer that complies with AWWA B-100 standards. Installation of support gravels shall be under the direct supervision of an employee of the contactor manufacturer experienced in this procedure. Flushing of calcite fines will be required and shall be the responsibility of the installing contractor.

2-3.05. Face Piping.

High pressure piping, fitting, and flanges shall be TIG welded stainless steel due to its ruggedness and high safety factor. Low pressure piping shall be Sch. 80 PVC with a UV protective coating that is suitable for outdoor exposure.

Valves shall be rated at or above the working pressure of the system, be of corrosion resistant materials.

Filter facepiping shall be provided by the contactor system manufacturer factory assembled with valves and instruments on skids for each vessel that will be attached to flanges on the vessels by installation contractor. Skids are to be constructed of powder coated carbon steel.

2-3.06. Valves.

The CSS shall furnish all valves as called for in these Specifications, as indicated on the Drawings and as required for proper operation of the equipment in all operating modes, including backwash. Valves shall be manufactured by a manufacturer whose valves have had successful operational experience in comparable service. The valve manufacturer shall furnish detailed technical information as required by the Design Builder for evaluating the quality of the valves and as required by the CSS for proper valve installation. The technical information shall include complete dimensions, weights, and material lists. No valve will be approved for installation until the required information has been received and reviewed. Valve size shall be as shown on the Drawings.

All function valves shall be lug style butterfly valves, and shall be one-piece disc through shaft constructed with resilient seats to ASTM A-126 Class B for mounting between two bolted flanges without the need for gaskets. Disc construction shall be Nylon 11 coated ductile iron ASTM A 536 Gr. 65-45-12. Valve shaft shall be one-piece stainless steel and supported on inert nylon bearings. Seat shall be EPDM material. Valves supplied shall be Bray Series 30, Dezurik BOS; or Design Builder pre-approved equal.

Where manual actuators are shown in the Drawings, they shall be hand-wheel type gear with cast iron housing and hand-wheel, position indicator, and have adjustable open and closed position stops.

2-4. POWER SUPPLY. Power supply to equipment will be 480 volts, 60 Hz, 3 phase. If other voltages other than 480V are required by the package, transformer(s) shall be provided as part of the panel package.

2-5. FACTORY HYDROSTATIC TESTING. Prior to shipment of equipment to the site, each fully-assembled calcite contactor vessel shall be subject to a factory hydrostatic test. Vessels shall be hydrostatically tested at the pressure required by the ASME Boiler and Pressure Vessel Code, Section VIII for the expected working pressure. Calcite contactor vessels, equipment, piping, and fittings that leak or lose pressure during the test shall be repaired or replaced at no cost to the Owner, and the test shall be repeated. The CSS shall submit certification of satisfactory completion of the factory hydrostatic testing to the Design-Builder prior to shipping the equipment to site.

2-6. INSTRUMENTATION

2-6.01. Loss of Head Gauge Panel.

The Contractor shall furnish and install a loss of head gauge panel. The gauge panel shall have the following 4-1/2” flush-mounted gauges:

- Inlet header (0-100 psi)
- Effluent header (0-100 psi)
- Loss of head - between influent and effluent headers (0-10 psi differential pressure gauge with switch)

Each panel shall be equipped with the following components:

Nameplates identifying gauges and sample taps.
Two flush mounted sample taps for influent and effluent locations.
Manufacturer nameplate, aluminum construction.

Manufacturer shall furnish mounting hardware (brackets, U-bolts, nuts, washers, etc.) for affixing to facepiping. Installation of panel shall be by Contractor.

2-6.02. pH Analyzers. pH analyzers shall be supplied in accordance with the Process Analytical Instruments section. The pH analyzer shall measure inlet and outlet pH. Indicating transmitters shall be panel mounted.

2-7. CONTROL PANELS. NEMA Type 4 stainless steel control panels shall be provided in accordance with the Panels, Consoles and Appurtenances section. All wiring to external devices shall terminate on numbered, pressure type terminal blocks. The PLC enclosure shall house the PLC and OIT. The backwash/flush pump local control panel shall house the pump's variable frequency drive.

Control power transformers shall have one secondary lead fused, the other grounded, and shall have capacity for all simultaneous loads. The complete control panel shall be rated for a short circuit current of 22,000 amperes at 480 volts ac.

All selector switches and pilot lights shall be 30.5-mm heavy-duty, oil-tight type. Indicating lights shall be push-to-test type, full voltage LED lamps
All relays shall have contacts rated 10 amperes at 120 volts ac.

2-7.01. Variable Frequency Drive. Variable Frequency drive shall be mounted in a local control panel.

2-7.02. Programmable Logic Controller and Operator Interface Terminal. The programmable logic controller (PLC) and operator interface terminal (OIT) shall be provided in accordance with the Programmable Logic Controller section. The OIT shall be mounted on the PLC enclosure's face and shall indicate the following, via a series of custom designed screens:

- Backwash/Flush
- Bar graph and Digital Displays of Times in Backwash/Flush
- Alarms/alarm acknowledges
- Other functions, indication and information as required for a complete operating system

2-7.03. Power Failure. If power to the PLC is lost, the uninterruptible power supply (UPS) shall engage and shall continue automatic operation of the filter control panel (all function and indication) for a minimum of 15 minutes. If a contactor vessel is in backwash mode, then the backwash process will be placed in hold until the return of power at which time it will resume and complete the process. The UPS shall be provided in accordance with the Uninterruptible Power Supply section.

2-7.04. Alarms. If required, the following alarms shall be indicated on the alarm OIT screen: flush required; flush abort; filter to waste watch dog timer; flush hold; and other alarm conditions affecting contactor operation.

2-7.05. Shop Testing Prior to Shipment. Prior to shipment the contactor control panel shall be fully tested with all alarms, indication and I/O fully simulated at the factory prior to shipment. All screens shall be tested along with all alarm functions and other control parameters, verified by factory certification as to inspector and date inspected. Testing shall be subject to verified witnessing by the Owner and/or Design Builder if required.

2-8. PAINTING. The interior of the vessel shall be sandblasted and protected from corrosion by proper application of approved coatings for potable water. The exterior of the vessel shall be sandblasted and prime painted at the factory.

2-8.01. Surface Preparation. Interior - Sandblasted to near white blast cleaning (SSPC-SP10 with a minimum sharp angular anchor profile of 1.5 mils).

Surface preparation shall include:

- Correct steel and fabrication defects revealed by surface preparation.
- Remove weld spatter and slag.
- All welds shall be ground to a smooth contour as per NACE Standard RP0178, Designation D for Lap, Butt and Fillet Welds.
- Smooth weld undercuts and recesses.
- Grind down porous welds to pinhole-free metal.
- Remove weld flux from surface.
- Exterior - Sandblasted to commercial blast cleaning (SSPC-SP6 with a minimum sharp angular anchor profile of 1.5 mils).

2-8.02. Coating. Interior - Stripe coating: hand-applied one coat Tnemec Series N140 or N140F Pota-Pox Plus in color 15BL Tank White to all welds and hard to reach areas using high quality natural or synthetic bristle brush, to a dry film thickness of 3-5 mils. Prime coating: Tnemec Series N140 or N140F Pota-Pox Plus in color 1255 Beige primer to a dry mil thickness of 3-5 mils before any rust can form. Finish coating: Tnemec Series N140 or N140F Pota-Pox Plus in color 15BL Tank White to a dry mil thickness of 4-6 mils for a total dry film thickness of 7- 11 mils.

Exterior - Stripe coating: hand-applied one coat Tnemec Series N140 or N140F Pota-Pox Plus in color 15BL Tank White to all welds and hard to reach areas using high quality natural or synthetic bristle brush, to a dry film thickness of 3-5 mils. Prime coating: Tnemec Series N140 or N140F Pota-Pox Plus in color 1255 Beige to a dry mil thickness of 3-5 mils before any rust can form. Finish coating: Tnemec Series N140 or N140F Pota-Pox Plus in color selected by Owner to a dry mil thickness of 4-6 mils for a total dry film thickness of 7-11 mils.

The total paint system shall be the product of and be applied in accordance with the recommendations of one manufacturer. Alternate paint systems must be pre-

approved by Design Builder. Contractor shall purchase an adequate amount of touch-up paint, if required. Uniformly apply coatings at spreading rate required to achieve specified DFT. Thickness of coatings and paint shall be checked with a non-destructive, magnetic-type thickness gauge, as per SSPC-PA 2 "Measurement of Dry Film Thickness with Magnetic Gages".

PART 3 – EXECUTION

3-1. EQUIPMENT INSTALLATION

3-2. FACTORY SERVICES AND START-UP

3-2.01. System Commissioning Plan. The CSS shall provide a detailed pre-installation checklist and System Commissioning Plan (SCP) as a tool for proper installation, and shall work closely with the Contractor to ensure the system is installed in accordance with the manufacturer's recommendations.

3-2.02. Calcite and Gravel Installation. Installation of support gravels and calcite shall be under the direct supervision of an employee of the calcite contactor manufacturer experienced in this procedure, in accordance with the Equipment Schedule.

3-2.03. System Start-Up and Training. See the Demonstration and Training section for information on training. The following is supplementary to the Demonstration and Training section.

An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Design-Builder.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

If the treatment system fails to meet any of the specified performance requirements, the Contractor and manufacturer shall modify and/or replace the necessary equipment to bring the system into compliance. After the modifications, the finished water shall be re- sampled and analyzed to verify satisfactory operation.

All costs for these services shall be included in the contract price.

End of Section

EQUIPMENT SCHEDULE

Parameter	**Value**
Calcite Contactor Vessels	
Design Flow Rate:	653 gpm (0.94 MGD)
Surface Loading Rate (upflow):	2.3 to 5.8 gpm/sf
Vessel Construction	
Vessel Diameter:	12 ft
Max. Vessel Side Shell Height:	84 inches
Design Working Pressure:	100 psig
Hydrostatic Test Pressure:	130 psig
Vessel Misc. Components	
1/2” Sample Taps per Cell	Influent, Effluent, and 18” above the gravel bed
Calcite Media	The calcite shall be placed on top of the support gravel and shall consist of a 36” depth of 0.4 mm particle size and shall be NSF-61 certified, Pur-Cal or equal. The media shall have a uniformity coefficient less than 1.5.
Pumps	
Type	TBD by calcite contactor equipment supplier
Rated Capacity	15 gpm/sf
Rated Head	TBD by calcite contactor equipment supplier
Efficiency, min	70%
Horsepower, max	40
Factory Services & Start-Up	
Equipment Installation Supervision:	2 days
Media Installation Supervision	3 days
Start-up & Operator Instruction	3 days
Minimum number of trips required	3