CITY OF AUSTIN
Austin Water

PROJECT MANUAL
Contract Documents and Technical Specifications

VOLUME 2 of 3

Hornsby Bend BMP Process Ammonia Removal Facility and Drainage Improvements

C.I.P. ID NUMBERS: 3164.125 AND 3164.094
SOLICITATION NUMBER: CLMC1165

CITY OF AUSTIN
Austin Water
625 E. 10th St, Austin, Texas 78701

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City Standard Technical Specifications

Series 100 - Earthwork

102S	03/25/2021	Clearing and Grubbing
111S	09/26/2012	Excavation
120S	09/26/2012	Channel Excavation
130S	09/26/2012	Borrow
132S	08/20/2007	Embankment

Series 200 – Subgrade and Base Construction

201S	06/17/2021	Subgrade Preparation
204	06/01/2023	Cement Treatment of Materials in Place
210S	02/24/2010	Flexible Base
220S	02/24/2010	Sprinkling for Dust Control
230S	08/20/2007	Rolling (Flat Wheel)
232S	08/20/2007	Rolling (Pneumatic Tire)
234S	08/20/2007	Rolling (Tamping)
236S	08/20/2007	Proof Rolling

Series 300 – Street Surface Courses

301S	08/20/2007	Asphalts, Oils, and Emulsions
306S	02/24/2010	Prime Coat
307S	02/24/2010	Tack Coat
312S	09/26/2012	Seal Coat
313S	02/24/2010	Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)
315S	09/26/2012	Milling Asphaltic Concrete Pavement and Non-Portland Cement Concrete Bases
316S	09/26/2012	Polymerized Asphalt Interlayer Seal
340	03/20/2024	Asphaltic Concrete Pavement
360S	09/26/2012	Concrete Pavement

Series 400 – Concrete Structures and Miscellaneous Concrete

401S	09/26/2012	Structural Excavation and Backfill
402	09/13/2022	Controlled Low Strength Material
403	04/14/2025	Concrete for Structures
405	09/13/2022	Concrete Admixtures
406S	09/26/2012	Reinforcing Steel
408S	11/13/2007	Concrete Joint Materials
409S	11/13/2007	Membrane Curing
410S	09/14/2021	Concrete Structures
411S	11/13/2007	Surface Finishes for Concrete
413S	11/13/2007	Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)
414S	11/13/2007	Concrete Retaining Walls
416S	11/13/2007	Waterstops
430S	11/15/2011	P.C. Concrete Curb and Gutter
431S	04/03/2009	Machine Laid Portland Cement Concrete Curb and Gutter
433S	12/09/2008	P.C. Concrete Driveways
436S	11/13/2007	P.C. Concrete Valley Gutters
439S	11/13/2007	Parking Lot Bumper Curbs
470S	03/26/2008	Curb Cuts for Sidewalk Ramps and Driveways

Series 500 – Pipe and Appurtenances

503	11/07/2022	Frames, Grates, Rings and Covers
504S	02/24/2010	Adjusting Structures
506	02/22/2021	Manholes
508S	02/24/2010	Miscellaneous Structures and Appurtenances
509S	09/26/2012	Excavation Safety Systems
510	06/02/2025	Pipe
511	03/10/2025	Water Valves
551	12/15/2021	Pipe Underdrains
559S	10/03/2013	Concrete Box Culverts
591S	01/04/2016	Riprap for Slope Protection
593S	02/24/2010	P.C. Concrete Retards

Series 600 – Environmental Enhancement

601S	11/14/2016	Salvaging and Placing Topsoil
602S	06/16/2008	Sodding for Erosion Control
604S	06/17/2021	Seeding for Erosion Control
605S	06/21/2007	Soil Retention Blanket
606S	06/21/2007	Fertilizer
608S	09/26/2012	Planting
609S	01/04/2016	Native Seeding and Planting for Restoration
610	04/14/2025	Preservation of Trees and Other Vegetation
620S	01/04/2016	Filter Fabric
632S	11/26/2001	Storm Inlet Sediment Trap
638S	01/04/2010	Pipe Outlet Sediment Trap
639S	08/18/2010	Rock Berm
641S	03/25/2021	Stabilized Construction Entrance
642S	09/01/2011	Silt Fence
648S	03/01/2022	Mulch Sock
660S	01/04/2016	Biofiltration Medium
661S	11/14/2016	Soil Decompaction

Series 700 – Incidental Construction

700S	09/26/2012	Mobilization
701S	09/26/2012	Fencing
703	09/22/1988	Fencing for Excavations

Series 800 – Urban Transportation

860S	09/26/2012	Pavement Marking Paint
875S	11/21/2005	Pavement Surface Preparation for Markings

Special Provisions to City Standard Technical Specifications

SP403S	09/26/2012	Concrete for Structures
SP406S	09/26/2012	Reinforcing Steel
SP410S	09/14/2021	Concrete Structures

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TXDOT 276S	11/21/2005	Cement Treatment (Plant-Mixed)

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02281	06/19/2026	Bypass Pumping
02360	06/19/2026	Termite Control

DIVISION 3 – CONCRETE

03350	06/19/2026	Concrete Finishing
03920	06/19/2026	Concrete Surface Repair

DIVISION 5 – METALS

05015	06/19/2026	Stainless Steel Fabrications
05120	06/19/2026	Structural Steel Framing
05500	06/19/2026	Metal Fabrications
05520	06/19/2026	Aluminum Handrails
05530	06/19/2026	Aluminum Grating
05531	06/19/2026	Metal Bar Gratings

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06100	06/19/2026	Rough Carpentry

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

07160	06/19/2026	Sheet Vapor Retarders
07210	06/19/2026	Pre-Engineered Building Insulation
07213	06/19/2026	Batt Insulation
07270	06/19/2026	Air Barriers
07415	06/19/2026	Metal Roofing
07468	06/19/2026	Metal Siding
07600	06/19/2026	Flashing and Sheet Metal
07714	06/19/2026	Gutters and Downspouts
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08110	06/19/2026	Steel Doors and Frames
08330	06/19/2026	Architectural Overhead Coiling Doors
08410	06/19/2026	Metal Framed Storefronts
08710	06/19/2026	Door Hardware
08800	06/19/2026	Glazing
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09511	06/19/2026	Acoustical Ceiling Panels
09650	06/19/2026	Resilient Flooring
09902	06/19/2026	Painting
09960	06/19/2026	High-Performance Coating

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10520	06/19/2026	Fire Protection Specialties

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11100	06/19/2026	Pumps General
11140	06/19/2026	Self-Priming Horizontal Non-Clog Pumps
11210	06/19/2026	Vertical-Shaft Mixers
11270	06/19/2026	MBBR Deammonification System
11305	06/19/2026	Submersible Non-Clog Sewage Pumps
11376	06/19/2026	Rotary-Lobe Blowers

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12355	06/19/2026	Metal Laboratory Casework
12494	06/19/2026	Roller Shades

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15004	06/19/2026	Couplings, Adapters, and Specials for Process Piping
15005	06/19/2026	Piping Identification
15006	06/19/2026	Hangers and Supports for Process Piping
15023	06/19/2026	Stainless Steel Process Pipe and Tubing
15084	06/19/2026	Ductwork Insulation
15145	06/19/2026	Process Piping and Equipment Insulation
15201	06/19/2026	Actuators for Process Valves and Gates
15202	06/19/2026	Butterfly Valves
15203	06/19/2026	Check Valves
15204	06/19/2026	Ball Valves
15205	06/19/2026	Common Requirements for Process Valves
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15252	06/19/2026	Miscellaneous Valves
15254	06/19/2026	Fabricated Stainless Steel Weir Gates
15400	06/19/2026	Plumbing Systems
15500	06/19/2026	Common Work Results for HVAC
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15740	06/19/2026	Heat Pumps
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16012	06/19/2026	Power Systems Study and Arc Flash
16020	09/30/2015	Utilities
16117	06/19/2026	Electrical Manhole and Concrete Pull Boxes
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16130	06/19/2026	Boxes and Cabinets
16140	09/30/2015	Wiring Devices
16150	09/01/2016	Raceways, Fittings and Supports
16191	10/24/2016	Miscellaneous Equipment
16200	09/30/2015	Wires, Conductors and Cable - 600V and Below
16205	09/30/2015	Wire and Cable Tagging
16220	06/19/2026	Motors
16400	08/22/2016	Surge Protective Devices
16425	06/19/2026	Low Voltage Switchboard
16440	08/22/2016	Disconnect Switches and Enclosed Circuit Breakers
16460	08/22/2016	Dry Type Transformers – 600 Volts and Below Primary Rated 150 KVA and Smaller
16480	06/19/2026	Variable Frequency Drives
16481	06/19/2026	Solid State Reduced Voltage Motor Starters
16500	08/22/2016	Panelboards
16510	06/19/2026	Lighting
16524	08/22/2016	480 V Automatic Transfer Switch
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17310	06/19/2026	Pressure Indicating Transmitter
17320	06/19/2026	Temperature Gauges
17345	06/19/2026	Radar Level Element & Indicating Transmitter
17370	06/19/2026	Mechanically Activated Level Switches
17600	06/19/2026	Programmable Logic Controllers (PLCs) & Operator Interface Units (OIUs)
17620	06/19/2026	Fiber Optic & Ethernet Communication Equipment
17900	06/19/2026	Plant Control Philosophy
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CP-02	06/19/2026	EQ Basin and EQ Transfer Pumps
CP-03	06/19/2026	Ammonia Treatment Reactor and Aeration Blowers
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CP-05	06/19/2026	PID Control – General
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END

FOR HORNSBY BEND BMP PROCESS AMMONIA REMOVAL FACILITY PROJECT
CIP NO. 3164.125

ENGINEERS:

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1905 Aldrich St., Suite 300
Austin, Texas 78723
Firm Registration Number: 6324

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Firm Registration Number: 882

CAS Consulting & Services
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Austin, Texas 78754
Firm Registration Number: 3572

Jose I. Guerra
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Firm Registration Number: 3

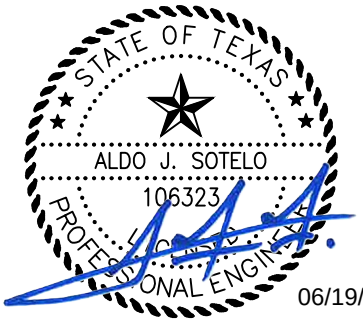
JRSA Engineering
6101 W. Courtyard Dr., Bldg. 1, Suite 200
Austin, Texas 78730
Firm Registration Number: 3997

Baer Engineering
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Austin, Texas 78757
Firm Registration Number

ARCHITECT

Negrete & Kolar Architects
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Austin, Texas 78753
Firm Registration Number: 426

Stantec Consulting Services
Firm Registration Number: 6324
Aldo Sotelo (P.E. 106323)



DIVISION 00 – BIDDING REQUIREMENTS, CONTRACT FORMS, & CONDITIONS OF THE CONTRACT

DIVISION 01 – GENERAL REQUIREMENTS

VOLUME 2 TECHNICAL SPECIFICATIONS

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DIVISION 09 – FINISHES (Section 09960)
DIVISION 11 – EQUIPMENT (Sections 11000, 11100, 11140, 11305)
DIVISION 15 – MECHANICAL (Sections 15001, 15004, 15005, 15006, 15201, 15202, 15203, 15204, 15205, 15207, 15252)

Sean Kirby (P.E. 139085)



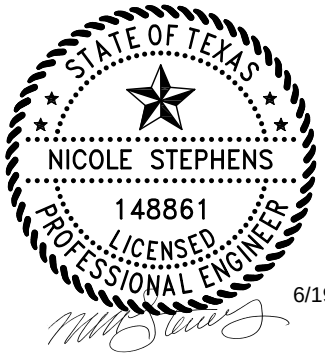
CITY STANDARD TECHNICAL SPECIFICATIONS

SERIES 500 – PIPE AND APPURTENANCES (503, 504S, 506, 509S, 510, 511)

VOLUME 2 TECHNICAL SPECIFICATIONS

DIVISION 02 – SITE CONSTRUCTION (Section 02081, 02281)

Nicole Stephens (P.E. 148861)



VOLUME 2 TECHNICAL SPECIFICATIONS

DIVISION 11 – EQUIPMENT (Sections 11210, 11270)
DIVISION 15 – MECHANICAL (Sections 15023, 15145, 15254)

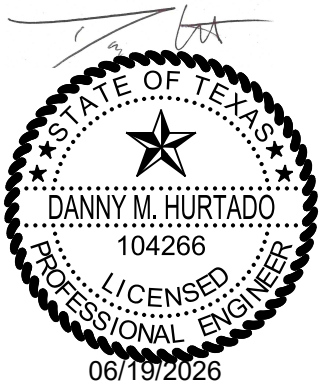
Barbara Herrera (P.E. 139500)



VOLUME 2 TECHNICAL SPECIFICATIONS

DIVISION 17 – INSTRUMENTATION AND CONTROLS (Sections 17100, 17102, 17122, 17200, 17310, 17320, 17345, 17370, 17600, 17620, 17900, I&C APPENDICES)

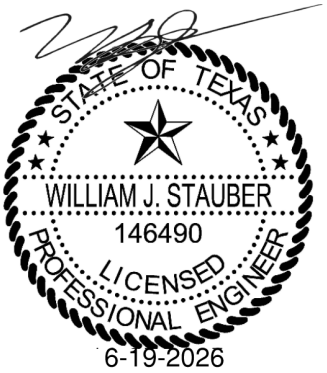
Carollo Engineers
Firm Registration Number: 882
Danny Hurtado (P.E. 104266)



VOLUME 2 TECHNICAL SPECIFICATIONS

DIVISION 11 – EQUIPMENT (Section 11376)

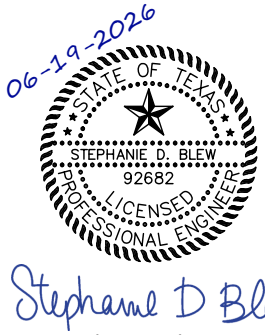
William Stauber (P.E. 146490)



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CAS Consulting & Services
Firm Registration Number: 3572
Stephanie Blew (P.E. 92682)



CAS Consulting and Services, Inc.
TBPE Registration Number F-3572

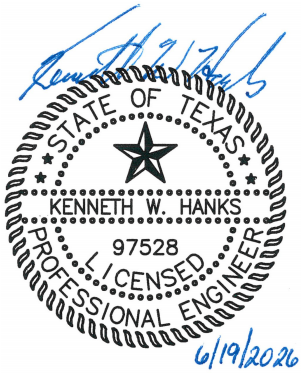
CITY STANDARD TECHNICAL SPECIFICATIONS

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SERIES 200 – SUBGRADE AND BASE CONSTRUCTION (201S, 204, 210S, 236S)
SERIES 300 – STREET SURFACE COURSES (301S, 306S, 307S, 312S, 313S, 340, 360S)
SERIES 400 – CONCRETE STRUCTURES AND MISCELLANEOUS CONCRETE (403S, 405, 406S, 408S, 409S, 411S, 413S, 430S, 431S, 433S, 436S, 439S, 470S)
SERIES 500 - PIPE AND APPURTENANCES (504S)
SERIES 600 – ENVIRONMENTAL ENHANCEMENT (601S, 602S, 604S, 605S, 606S)
SERIES 800 – URBAN TRANSPORTATION (860S, 875S)

TXDOT SPECIFICATIONS

TXDOT SPECIFICATIONS – TXDOT 276S

Jose I. Guerra
Firm Registration Number: 3
Kenneth Hanks (P.E. 97528)



CITY STANDARD TECHNICAL SPECIFICATIONS

SERIES 400 – CONCRETE STRUCTURES AND MISCELLANEOUS CONCRETE (401S, 402, 403, 406S, 410S, 411S, 413S)

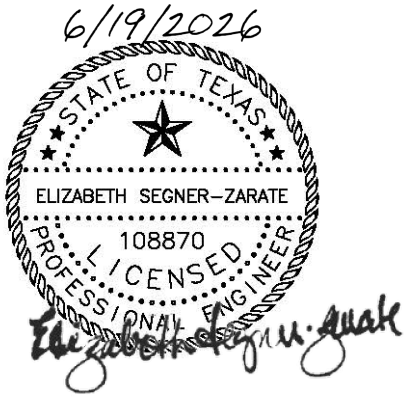
SPECIAL PROVISIONS TO CITY STANDARD TECHNICAL SPECIFICATIONS

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DIVISION 05 – METALS (Sections 05015, 05120, 05500, 05520, 05530, 05531)
DIVISION 13 – SPECIAL CONSTRUCTION (Section 13120)

JRSA Engineering
Firm Registration Number: 3997
Elizabeth Segner-Zarate (P.E. 108870)



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DIVISION 16 – ELECTRICAL (Sections 16010, 16011, 16012, 16020, 16117, 16120, 16130, 16140, 16150, 16191, 16200, 16205, 16220, 16400, 16425, 16440, 16460, 16480, 16481, 16500, 16510, 16524, 16550, 16601, 16950)

Baer Engineering
Firm Registration Number: 3181
Therese Baer (P.E. 64040)



06/19/2026

CITY STANDARD TECHNICAL SPECIFICATIONS

SERIES 600 – ENVIRONMENTAL ENHANCEMENT (601S, 602S, 604S, 605S, 606S)

Negrete & Kolar Architects
Firm Registration Number: 426
David Negrete (R.A. 11640)



06/19/2026

VOLUME 2 TECHNICAL SPECIFICATIONS

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DIVISION 03 – CONCRETE (Section 03350)
DIVISION 06 – WOOD AND PLASTICS (Section 06110)
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DIVISION 10 – SPECIALTIES (Sections 10400, 10520)
DIVISION 12 – FURNISHINGS (Sections 12346, 12355, 12494)

END

ENGINEER FOR HORNSBY BEND DRAINAGE IMPROVEMENT PROJECT CIP NO. 3164.094

Walker Partners, LLC
6504 Bridge Point Parkway, Suite 200
Austin, Texas 78730
Firm Registration Number: 8053

Walker Partners, LLC
S. Jared Niermann, P.E.



For CIP No. 3164.094:

Document Number	Revision Date	Document Name

City Standard Technical Specifications Walker Partners is Responsible For:

Series 100 – Earthwork		
102S	03/25/2021	Clearing and Grubbing
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401S	09/26/2012	Structural Excavation and Backfill
402	09/13/2022	Controlled Low Strength Material
403	04/14/2025	Concrete for Structures
405	09/13/2022	Concrete Admixtures
406S	09/26/2012	Reinforcing Steel
408S	11/13/2007	Concrete Joint Materials
409S	11/13/2007	Membrane Curing

Document Number	Revision Date	Document Name

City Standard Technical Specifications Walker Partners is Responsible For Cont'd:

Series 400 – Concrete Structures and Miscellaneous Concrete Cont'd		
410S	09/14/2021	Concrete Structures
411S	11/13/2007	Surface Finishes for Concrete
413S	11/13/2007	Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)
414S	11/13/2007	Concrete Retaining Walls
416S	11/13/2007	Waterstops
430S	11/15/2011	P.C. Concrete Curb and Gutter
Series 500 – Pipe and Appurtenances		
503	11/07/2022	Frames, Grates, Rings, and Covers
506	02/22/2021	Manholes
508S	02/24/2010	Miscellaneous Structures and Appurtenances
509S	09/26/2012	Excavation Safety Systems
510	06/02/2025	Pipe
551	12/15/2021	Pipe Underdrains
559S	10/03/2013	Concrete Box Culverts
591S	01/04/2016	Riprap for Slope Protection
593S	02/24/2010	P.C. Concrete Retards
Series 600 – Environmental Enhancement		
601S	11/14/2016	Salvaging and Placing Topsoil
604S	06/17/2021	Seeding for Erosion Control
605S	06/21/2007	Soil Retention Blanket
606S	06/21/2007	Fertilizer
608S	09/26/2012	Planting
609S	01/04/2016	Native Seeding and Planting for Restoration
610	04/14/2025	Preservation of Trees and Other Vegetation
620S	01/04/2016	Filter Fabric
632S	11/26/2001	Storm Inlet Sediment Trap
638S	01/04/2010	Pipe Outlet Sediment Trap
639S	08/18/2010	Rock Berm
641S	03/25/2021	Stabilized Construction Entrance
642S	09/01/2011	Silt Fence
648S	03/01/2022	Mulch Sock
660S	01/04/2016	Biofiltration Medium
661S	11/14/2016	Soil Decompaction
Series 700 – Incidental Construction		
700S	09/26/2012	Mobilization
701S	09/26/2012	Fencing
703	09/22/1988	Fencing for Excavations

Special Specifications Walker Partners is Responsible For:

SS4150	08/06/2021	Contaminated Soil and Water

END

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide precast concrete manholes and vaults, complete and in place, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals

B. Reference Standards

American Society for Testing and Materials (ASTM) Standards	
ASTM A48	Gray Iron Castings
ASTM C150	Portland Cement
ASTM C443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C478/C478M	Standard Specifications for Circular Precast Reinforced Concrete Manhole Sections
ASTM C857-19	Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.03 SUBMITTALS

A. General: Furnish submittals in accordance with Section 01300 – Submittal Procedures.

B. Shop Drawings

1. Show dimensions, locations, lifting inserts, reinforcement, pre-cast openings, thin-wall knock-out sections, and joints.

2. Structural design calculations for vaults, signed by a registered State of Texas-licensed Professional Engineer.

C. Manufacturer's Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

1.04 QUALITY ASSURANCE

A. Inspection: After installation, the CONTRACTOR shall demonstrate that vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART II - PRODUCTS

1.05 VAULTS

A. The CONTRACTOR shall provide precast vaults designed for the indicated applications and of the sizes indicated, designed by a State of Texas-licensed Professional Engineer in compliance with the design requirements contained herein.

B. Vault pre-casters shall be certified by the National Precast Concrete Association (NPCA). Concrete shall be supplied by an off-site ready-mix plant certified by the National Ready Mixed Concrete Association (NRMCA) or by an on-site plant certified by NPCA.

C. Vault pre-caster shall be listed on the City of Austin Standard Product List WW-298, Pre-cast Water Utility Vaults.

D. The minimum structural member thickness for vault walls shall be 6-in or 8-in, as required by vault pre-caster. Precast concrete shall conform to Description Item 8 in SPL WW-298, Pre-cast Water Utility Vaults. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

E. Design Loading: Vault will be subject to vehicular traffic and shall be designed for A-16 Vehicle loads.

F. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

G. Where openings for access to the vault are required, the full clear space indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

H. Access hatch manufacturer shall be listed on the City of Austin Standard Product WW-614, Access Doors 36-Inch By 36-Inch.

I. Hatches shall meet material and safety requirements listed in Description and Notes of City of Austin's SPL WW-614, Access Doors 36-Inch By 36-Inch. Frames for hatches shall be fabricated from steel, galvanized after fabrication, and shall be integrally cast into the vault concrete sections.

J. Precast vault top slab shall be designed to accommodate the DBI-SALA personnel lift mounting plate, which CONTRACTOR shall install where indicated in the plans. The CONTRACTOR is NOT responsible for providing a personnel lift.

K. Where penetration of the pre-cast concrete vault is required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. Vaults need not be designed to resist thrust from piping passing through the vault.

PART III - EXECUTION

1.06 GENERAL

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the MANUFACTURER's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the CONTRACTOR shall follow the pre-caster manufacturer's recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations or bedding as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Prior to backfilling, all cracks and voids in pre-cast concrete vaults shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant or link seal. With the authorization of the ENGINEER, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. This specification section governs bypass pumping of the dewatering filtrate from the Belt Filter Press (BFP) Dewatering Building or sections of pipe designated for rehabilitation.

B. The work covered by this speciation consists of furnishing all labor, supervision, tools, equipment, appliances, and materials to perform all operations in connection with pumping of dewatering filtrate from the BFP Dewatering Building to the existing Hornsby Bend Ponds. The purpose of this bypass pumping is to preclude the use of the existing BFP Effluent Lift Station or other existing pipes while they are being rehabilitated or replaced. The CONTRACTOR shall maintain dewatering filtrate and other existing flows in and around the construction area to prevent back-up and/or overflow into adjacent ditches, storm sewers, and waterways.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals

1.03 DEFINITIONS

A. By-pass pumping is the installation and operation of bulkheads, plugs, hoses, piping, and pumps to maintain dewatering filtrate or other flow and prevent backup and overflow.

B. By-pass pumping provides continuous discharge of the dewatering filtrate or other flow while maintenance or construction operations are in progress by diverting flow, when necessary, around the construction location and pumping dewatering filtrate to the Hornsby Bend Ponds or other flows to a downstream existing connection or manhole.

1.04 CONTRACTOR'S RESPONSIBILITY

A. It is the sole responsibility of the CONTRACTOR to provide any and all labor, material, equipment, techniques and methods to bypass pump as necessary for their construction methods and to monitor the effectiveness of this installed system and its effect on adjacent facilities.

B. Operate, maintain and modify the system(s) as required to conform to this specification. Upon completion of the Construction, CONTRACTOR shall remove the system(s).

C. Assume sole responsibility for bypass pumping systems and for all loss or damage resulting from partial or complete failure of protective measures and any spills or resultant damage caused by his operation.

1.05 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals

B. The CONTRACTOR shall provide a written description and plan/sketch for implementation and sequencing of bypass pumping for review and approval of the OWNER prior to installation of the bypass system. The plan shall include sufficient detail to show the location, number and size of pumps, the number, location, size and type of hoses and/or rigid piping, and the location of the downstream discharge. Show any special features where pipes or hoses cross roadways, such as temporary trenches, support bridges, etc. A plan for each line segment(s) around which flows are being bypassed is required. The plan shall include but not be limited to details of the following:

1. Project information including the project name, location, and permit number (from plan cover sheet).

2. Contact information for general CONTRACTOR/submitting entity shall include the company name, contact person (24hrs/day), phone number(s), and fax number.

3. Staging areas for pumps including a schematic showing the arrangement and layout of the pumping and bypassing facilities at various stages in the work.

4. Plugging method and types of plugs.

5. Calculations for selection of bypass pump and pipe size(s) based on flows.

6. Length, size, material, location and method of installation of suction piping.

7. Length, size, material, location, method of installation and location of discharge hose.

8. Pump manufacturer model and pump curve.

9. Calculations of static lift, friction losses, and flow velocity, (pump curves showing pump operating range shall be submitted).

10. Downstream discharge plan.

11. Method of protecting discharge manholes or structures from erosion, damage, and unauthorized entry.

12. Method of noise control for each pump and expected decibel levels.

13. Any temporary pipe supports and anchoring, if required.

PART II - PRODUCTS

2.01 DESIGN

A. Bypass pumps shall be sized to adequately handle the flows listed in the table below without backups or surcharges to the system.

Dewatering Filtrate

Average Daily Flow (mgd)	0.79
Peak Week Flow (mgd)	0.92

2.02 MATERIALS

A. The pump and bypass pumping lines shall be of adequate capacity and size to handle peak wet weather flows as shown in section 2.01. All piping, joints, and accessories shall be designed to withstand at least twice the maximum system pressure, or a minimum of 50 psi, whichever is greater.

B. Heavy wall discharge hose shall be used. Four-inch and six-inch diameter discharge hose shall be capable of limited traffic driving over the hose for situations where the hose crosses a driveway. All bypass piping and hoses shall be in good condition and shall be free of leaks. Pumps shall be self-priming, in good working order, with a working pressure gauge on the discharge. A back-up pump of the same capacity as the primary pump shall be maintained on site at all times to be used in the event that the primary pump fails. No wastewater shall be allowed to drain or stand in earthen sump pits.

C. CONTRACTOR shall use sound attenuated pumps for all bypass pumping. Sound attenuated pumps shall reduce noise generated by the equipment to a maximum of 70 dBA when measured 30 feet from the pump.

D. Any back-ups and/or overflows as the result of inadequate equipment are the responsibility of the CONTRACTOR.

PART III - EXECUTION

3.01 CONSTRUCTION METHODS

A. The CONTRACTOR's efforts shall maintain existing flow to prevent backup with the goal of preventing an overflow onto unpaved areas or into buildings, adjacent ditches, storm sewers, and waterways. The CONTRACTOR shall take all necessary steps to prevent flooding of public or private property. Maintaining flow inside the existing pipe during rehabilitation operations is preferred.

B. Any time the bypass pump(s) are operating, an experienced operator shall be on site to monitor the operation: adjust pump speed, valves, etc.; maintain and make minor repairs to the system; and report problems.

C. Where work requires bypassing beyond working hours, the CONTRACTOR shall operate bypass pumping and man the system for twenty-four (24) hours per day.

D. CONTRACTOR shall ensure that no damage will be caused to existing or proposed facilities as a result of bypass pumping operations. Access to adjacent buildings shall be maintained at all times including driveways. Ramps, steel plates, or other methods shall be employed by the CONTRACTOR to facilitate traffic over surface piping and hose. High traffic commercial properties may require alternate methods to maintain access.

E. CONTRACTOR shall complete the Work as quickly as possible and satisfactorily pass all tests, inspections, and repair all deficiencies prior to discontinuing bypass pumping operations and returning flow to the BFP Effluent Lift Station or line segment.

F. During bypass pumping, do not allow flow to be leaked, dumped, or spilled in or onto any area outside of the existing sewer system.

G. In the event of accidental spill or overflow, immediately stop the discharge and take action to clean up and disinfect the spill, and promptly notify the OWNER.

H. In the event of accidental spill or overflow, the CONTRACTOR is responsible for any damages that may have occurred to public or private property including cleaning, disinfection, and other corrections to the satisfaction of OWNER, at no cost to the OWNER.

I. CONTRACTOR shall not intentionally damage, alter, or remove portions of the existing structures for the purpose of installing a bypass pumping system without specific approval from the OWNER. If a structure is damaged, it shall be reconstructed or replaced to the satisfaction of the OWNER, at no additional cost to the OWNER.

J. The CONTRACTOR shall be responsible for any and all damage that results directly or indirectly from the interference of storm water runoff to bypassing equipment, piping, and/or appurtenances.

K. When bypass pumping operations are complete, piping shall be drained into the BFP Effluent Lift Station prior to disassembly, and all pumps and lines shall be flushed with clean water until all discharge is clear.

L. Plugging a manhole and holding dewatering filtrate or any other bypassed liquid in a manhole while work is performed downstream is unacceptable.

3.02 SCHEDULING

A. The CONTRACTOR shall report any bypass pumping activities not included in the submitted plan to the OWNER and Inspector prior to proceeding with these activities.

B. The CONTRACTOR shall cease bypass pumping operations when directed by the OWNER or Inspector.

C. The CONTRACTOR shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to actual operation. The OWNER and Inspector will be given a 24-hour notice prior to testing.

D. The CONTRACTOR shall coordinate the lift station rehabilitation and bypass pumping schedule with removal of the existing underground electrical utilities providing power to the BFP lift station. The CONTRACTOR shall provide a detailed schedule of this work to the OWNER and ENGINEER for approval.

E. The CONTRACTOR shall be responsible for maintaining electrical power to the BFP lift station prior to and following the bypass pumping operation and lift station rehabilitation.

3.03 MEASUREMENT

A. No separate payment will be made for installation, operation and maintenance of bypass pumping system. The costs for bypass pumping are considered as subsidiary to the installation or replacement of the BFP Effluent Lift Station as indicated in the related contract specifications.

3.04 PAYMENT

A. The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" are considered subsidiary to the installation or replacement of the BFP Effluent Lift Station as indicated in the related contract specifications.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Stainless steel mesh barrier for termite control below and above grade. At interior penetrations of the foundation and the exterior foundation perimeter of new construction, as indicated in the drawings.

1.02 RELATED SECTIONS:

A. Section 360S – Concrete Pavement.

B. Section 410S – Concrete Structures.

C. Section 06100 – Rough Carpentry: Wood framing.

1.03 REFERENCES

A. National Pest Management Association:

1. ICC – International Code Congress.

2. NPMA WDO – Wood Destroying Organism Library.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 – Submittals: Requirements for submittals.

B. Product Data:

1. Stainless Steel Mesh:

a. Submit manufacturer’s data on stainless steel mesh and accessories.

b. Governing ICC ES Report for product to be installed.

c. Shop Drawings:

1) Submit scaled shop drawings prepared specifically for Project to illustrate details, dimensions, and other data necessary to fully describe installation of termite control.

2) Provide details of each proposed assembly identifying intended products and other similar information.

3) Show adjacent or related portions of Work coordinated in a complete manner.

4) Coordinate Shop Drawings submittal with submittals for related ports of works, including:

a) Section 360S – Concrete Pavement.

b) Section 410S – Concrete Structures.

c) Section 06100 – Rough Carpentry.

C. Test Reports: Indicate regulatory agency approval reports.

D. Manufacturer's Application Instructions:

1. Manufacturer’s instructions for installation/application. Include Manufacturer’s storage and handling requirements, site preparation and care, cleaning instructions, and other recommendations.

E. Installer’s Certificate:

1. Certify installer/applicator is licensed for termite control at the project location.

2. Certify installer/applicator is trained and approved by manufacturer with not less than 5 completed projects similar in scope and complexity to the project requirements. Submit list of complete projects of similar scope and complexity.

F. Warranty: Submit sample warranty.

G. CLOSEOUT SUBMITTALS

1. Section 01700 - Contract Closeout: Requirements for submittals.

2. Project Record Documents: Include record document.

3. Warranty: Submit warranty dated to commence upon Substantial Completion of the project.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing the Work of this section with minimum 3 years documented experience, trained and approved by manufacturer with a minimum of 5 completed projects of similar size and scope to the requirements of this project. Installer shall have not less than a Level 3 accreditation.

1.08 SEQUENCING

A. Section 01010 – Summary of Work: Work sequence.

B. Sequence installation with following in order to maintain integrity of each component:

1. Expansion joints: Install stainless steel mesh barrier.

2. Electrical, plumbing and HVAC equipment, conduit and piping: Install stainless steel mesh barrier.

3. Under-slab moisture.

4. Reinforcing steel.

1.09 PRE-INSTALLATION MEETINGS

A. Section 01400 – Quality Control Services: Pre-installation meeting.

B. Convene minimum two weeks prior to commencing work of this section.

C. Required attendees: OWNER, Architect, Structural Engineer, General Contractor, sub-contractor installing concrete, mechanical, plumbing, and electrical installers, and installer of the work of this section.

1.10 WARRANTY

A. Section 01700 - Contract Closeout: Requirements for warranties.

B. Furnish ten year warranty. Manufacturer to certify that stainless steel mesh will prevent infestation of subterranean and Formosan termites.

C. Warranty: Include coverage for damage and repairs to building and building contents caused by termites. Repair damage. Re-treat where required.

D. Inspect and report annually, during warranty period, to OWNER in writing.

1.11 NOT USED

PART 2 - PRODUCTS

2.01 MATERIALS

A. Stainless Steel Mesh Barrier System:

1. Manufacturer:

a. Termi-mesh manufactured by Termimesh, LL.

b. Substitutions: Section 01600 - Product Requirements.

2. Stainless Steel mesh:

a. Product: Termi-Mesh, Termistop Wire Diameter: 0.08 in.

b. Marine Grade, Type 725.

c. Mesh Size: 0.025 x 0.018 inches.

3. Accessories:

a. Stainless Steel Clamps: As recommended by stainless steel mesh barrier manufacturer.

b. Parging Compound: Specialized bonding cement as recommended by stainless steel mesh barrier manufacturer.

c. Bonding Cement: As recommended by stainless steel mesh manufacturer.

B. Design Criteria:

1. Place Mesh barrier across openings, joints, penetrations, and other termite entry points to building. Clamp, parge adhere, bond and/or embed mesh to surface surrounding opening. Metal mesh barrier shall be provided at, but not limited to, the following locations:

    a. Penetrations through ground floor slabs/foundations.

    b. Expansion and control joints on ground floor slabs and foundations: Saw cut joints do not require treatment unless deeper than 1/4-inch in depth.

    c. Perimeter exterior masonry adjacent to grade.

    d. Perimeter footings to adjacent concrete flatwork.

    e. Other areas determined by Manufacturer's representative to be hidden entry for termites.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01200 – Project Meetings: Verification of existing conditions before starting work.

B. Verify final grading and excavation are complete.

C. Examine substrates, areas, and conditions under which application of termite control shall be performed.

1. Examine interface with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control. Do not proceed until unsatisfactory conditions have been corrected. Commencement of installation constitutes acceptance of conditions and responsibility for satisfactory performance.

3.02 PREPARATION

A. General Requirements:

1. Remove extraneous sources of wood cellulose and other termite edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations/slabs.

3.03 INSTALLATION

A. Install mesh barrier system in compliance with Manufacturer's written instructions in a manner that will prevent termite penetration of slab and below grade walls where future construction is indicated.

B. Place metal mesh barrier where indicated on shop drawings to provide a continuous barrier to entry of subterranean termites.

C. Fit mesh tightly around pipe or other penetrations, and terminate at slab and foundation perimeters.

D. Install mesh under perimeter of concrete slab edges and joints after vapor barrier and reinforcing steel are in place, and comply with Manufacturer's written installation methods.

E. Apply corrosion resistant material to steel reinforcing to prevent direct contact with metal mesh.

F. Install mesh, clamps, and parging compound to provide permanent installation capable of preventing termite entry above slab at locations indicate Provide barrier within slab thickness where possible.

G. Install mesh with no gaps, penetrations, or damage.

H. Apply Manufacturer provided identification tape above concrete level to mark barrier locations.

3.04 PROTECTION OF FINISHED WORK

A. Section 01700 - Contract Closeout: Protecting finished Work.

B. Protect installed mesh termite control system, attachments, and accessories before, during, and after work of other trades. In the event other trades, following installation of mesh, move or damage mesh, clamps, or parging mix, immediately contact mesh installer for recommendation of necessary repairs.

3.05 SCHEDULE

A. Termite Control Barrier shall be provided for the following buildings:

1. Blower Building.

END OF SECTION 02360

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Finishing concrete floors and floor toppings.

2. Floor surface treatment.

1.02 RELATED REQUIREMENTS

A. Section 403S – Concrete for Structures: Prepared concrete floors ready to receive finish; control and formed expansion and contraction joints and joint devices.

B. Section 408S – Concrete Joint Materials: Floor, wall, and ceiling expansion or control joint cover assemblies.

C. Section 07900 - Joint Sealers: Sealants, sealers, and gaskets for sealing joints.

1.03 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete for Buildings.

2. ACI 302.1 - Guide to Concrete Floor and Slab Construction.

B. ASTM International:

1. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

2. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.

3. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.

4. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.

5. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.

6. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.

7. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

C. California Department of Public Health:

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

D. South Coast Air Quality Management District:

1. SCAQMD Rule 1113 - Architectural Coatings.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit manufacturer information on concrete hardener, sealer, compatibilities, and limitations.

C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

D. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate:

a. Certify that products meet or exceed specified sustainable design requirements.

b. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

2) Certify source for regional materials and distance from Project Site.

c. Indoor Air Quality Certificates: Certify VOC content for each flooring system.

3. Product Cost Data:

a. Submit cost of products to verify compliance with Project sustainable design requirements.

b. Exclude cost of labor and equipment to install products.

c. Provide cost data for following products:

1) Products with recycled material content.

2) Regional products.

E. CLOSEOUT SUBMITTALS

1. Section 01700 – Contract Closeout: Requirements for submittals.

2. Operation and Maintenance Data: Submit information on maintenance renewal of applied coatings.

1.07 COORDINATION

A. Section 01310 – Schedules and Reports: Requirements for coordination.

B. Coordinate Work of this Section with concrete floor placement and concrete floor curing.

1.08 QUALITY ASSURANCE

A. Perform Work according to ACI 301 and 302.1.

1.09 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Temporary Lighting:

1. Light Source: Minimum 200 W.

2. Quantity: One for each 425 sq. ft. of floor being finished.

3. Placement: 8 feet above floor surface.

C. Temporary Heat: Maintain minimum ambient temperature of 50 deg. F.

D. Ventilation: Sufficient to prevent injurious gases from temporary heat or other sources from affecting personnel or concrete.

PART 2 - PRODUCTS

2.01 COMPOUNDS - HARDENERS

A. Metallic Hardener:

1. Designation: MH-IO or MH-AO
2. Premixed.
3. Dry powder.
4. Color: similar to concrete
5. Oxidizable metallic.
6. Manufacturers:
    a. BASF, MasterTop 120SR, 200, 210COR or 300
    b. Dayton Superior Corporation, Ferro Tuff
    c. Euclid Chemical Company: Euco-Plate HD or Diamond-Plate
    d. Lambert Corporation, EMAG-20.
    e. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.02 COMPOUNDS - SEALERS

A. Sealer:

1. Designation: SL-AC
2. Type: Acrylic semi-gloss.
3. Color: Clear.
4. Manufacturers:
    a. Scofield, Selectseal Plus as basis of design.

b. Euclid Chemical Company (The); an RPM company.

c. Vexcon Chemicals Inc.

d. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.03 SLIP-RESISTANT TREATMENT

A. Slip resistant additive for sealer.

1. Designation: SR-PB

2. Material: Polymer.

3. Manufacturers:

a. Euclid Chemical Company, Euco Grip.

b. Exterior Performance Coatings, Inc., Anti-Slip Poly bead Epoxy Polyaspartic Urethan Additive.

c. H&C, SharkGrip.

d. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.04 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles of Project Site.

C. Indoor Environmental Quality Characteristics:

1. Flooring Systems: Maximum VOC content according to product and testing requirements of CA/DHS/EHLB/R-174.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for application examination.

B. Verify that floor surfaces are acceptable to receive Work of this Section.

3.02 APPLICATION

A. Concrete Floor Finishing:

1. Comply with ACI 301 and ACI 302.1.

2. Steel-trowel surfaces receiving resilient flooring.

3. Steel-trowel surfaces which are scheduled to be exposed but not polished.

4. Floor Drains:

a. In areas with floor drains, maintain design floor elevation at walls.

b. Slope surfaces uniformly to drains as indicated on Drawings.

B. Floor Surface Treatment:

1. Apply dry-shake hardener on floor surfaces as indicated in schedule following END OF SECTION.

2. Apply slip-resistant finish on floor surfaces as indicated in schedule following END OF SECTION.

3. Apply sealer on floor surfaces.

4. Provide Smooth Rubbed using a carborundum brick in accordance with ACI 301, section 5.3.3.4.

C. Exterior Concrete Walking Surfaces:

1. Comply with ACI 301 and ACI 302.1.

2. Broom Finish surfaces indicated as walkways and patios as scheduled.

3.03 TOLERANCES

A. Section 01400 – Quality Control Services: Requirements for tolerances.

B. Measure for F_F and F_L tolerances for floors according to ASTM E1155, within 72 hours after slab installation.

1. Measurements shall be taken include the edges at the construction joints and not just 2 feet in as indicated in ASTM E1155.

2. Finished Concrete: (SOV = Specified Overall Value, MLV = Minimum Local Value)

3. Under Resilient Finishes, and areas not outlined otherwise in this article:

a. F_F 35 SOV, 24 MVL, and;

b. F_L 25 SOV, 17 MLV.

4. Exposed to view in utility areas (mechanical, electrical, general storage):

a. F_F 25 SOV, 17 MLV, and;

b. F_L 20 SOV, 15 MLV.

5. Correct slab surface when actual F_F or F_L number for floor installation measures less than required.

3.04 ATTACHMENTS

A. Metallic Hardener: MH-IO or MH-AO

1. Locations: All floors.

B. Clear Sealer: Clear sealer type SL-AC

1. Locations: All floors.

C. Slip Resistant: Apply slip resistant dry shake to slab during curing.

1. Locations: Blower Room (05-100), Electrical Room (05-102), Mechanical Room (05-103).

D. Reference finish schedule and floor finish plan for more information.

END OF SECTION 03350

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PART I - GENERAL

1.01 SCOPE

A. This section covers the repair of existing concrete surfaces as indicated on the drawings, as specified, or as required to complete the Work. This specification covers the furnishing of all labor, equipment and materials required to repair, rehabilitate or reconstruct spalled, deteriorated, or structurally damaged concrete surfaces. Depth of repairs shall be adequate to restore concrete members to original dimensions and surface profiles.

B. The Work covered by this section includes, but is not limited to, the following locations:

1. BFP Effluent Lift Station

1.02 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals

B. The following items shall be submitted, as a minimum:

1. Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

2. Experience record of the applicator.

3. A letter from each product manufacturer indicating their approval of the following.

a. Selection of repair material.

b. Qualifications of the individuals performing the work.

c. Surface preparation procedures.

d. Application procedures.

e. Curing procedures.

1.03 QUALITY ASSURANCE

A. Manufacturer's Field Services

1. The material manufacturer shall provide engineering field services to review the project and the selected material application prior to any preparation; to approve the applicator, the material used, and the procedure to be used; to observe and approve surface preparation;

and to observe application and curing procedures. The field representative of the material manufacturer shall submit, in writing through CONTRACTOR, approvals of proposed materials, surface preparation, applicator, and application procedures. The field representative shall instruct the applicator, as needed, to assure that handling, mixing, placing, finishing, and curing of materials are in accordance with specifications and manufacturer's requirements. The field representative shall be an employee of the material manufacturer.

B. Applicator

1. The repair CONTRACTOR shall have experience and proficiency specific to the repair type and shall be acceptable to ENGINEER and the material supplier. The applicator shall submit, through CONTRACTOR, a satisfactory experience record including references for previous application of the specified materials to concrete structures of similar design and complexity.

C. Site Conditions

1. Job conditions shall be maintained at standards that allow material placement within temperature and cleanliness requirements. Unusual conditions or unexpected additional deterioration uncovered during the course of Work by CONTRACTOR shall be brought to ENGINEER's attention for analysis and disposition. These conditions include but are not limited to poor quality base concrete, severely corroded reinforcing steel, random cracks, deep oil penetration and any other condition which would prevent completion of the Work in accordance with manufacturer's recommendations and this specification.

PART II - PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Concrete repair products shall be manufactured by the Euclid Chemical Company, Master Builders Solutions, Sika Corporation as specified herein. Equivalent products of other manufacturers regularly producing high quality concrete repair materials, providing engineering field services, and meeting the specified quality assurance requirements may be furnished subject to acceptance by ENGINEER.

2.02 MATERIALS

A. Unless otherwise specified or authorized, materials shall conform to the requirements specified herein. Types of materials or concrete repair 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 field representative and acceptable to ENGINEER.

B. Products shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

C. Floor Surface Repairs, Thickness of 1/4 inch or Less

1. One or two component, polymer modified, cementitious material.

a. Compressive strength

1) 6,000 psi at 28 days using 2 inch cubes, per ASTM C109.

b. Products

1) Master Builders Solutions "MasterEmaco N 300 CI"

2) Euclid "Thin-Top Supreme"

3) Sika "SikaTop 121 Plus

c. Bonding agent

1) Repair mortar scrub coat per manufacturer's instructions

D. Floor Surface Repairs, Thickness between 1/4 inch and 1 Inch

1. One or two component, polymer modified, cementitious material containing a corrosion inhibitor.

a. Compressive strength

1) 7,000 psi at 28 days using 2 inch cubes, per ASTM C109.

b. Flexural Strength

1) 1100 psi at 28 days, per ASTM C348

c. Bond Strength

1) 2000 psi at 28 days, per ASTM C883

d. Products

1) Master Builders Solutions "MasterEmaco T 310 CI"

2) Euclid "VersaSpeed LS100"

3) Sika "SikaTop 122 Plus

e. Bonding agent

1) Repair mortar scrub coat per manufacturer's instructions

E. Floor Surface Repairs, Thickness Greater Than 1 Inch

1. One component, polymer modified, cementitious material containing a corrosion inhibitor.

a. Compressive strength

1) 7,000 psi at 28 days using 2 inch cubes, per ASTM C109.

b. Flexural Strength

1) 1100 psi at 28 days, per ASTM C348

c. Bond Strength

1) 2000 psi at 28 days, per ASTM C882

d. Products

1) Master Builders Solutions "MasterEmaco T 310 CI"

2) Euclid "VersaSpeed LS100"

3) Sika "SikaTop 122 Plus"

e. Bonding agent

1) Repair mortar scrub coat per manufacturer's instructions

F. Vertical and Overhead Surface Repairs, Trowel Applied

1. One or two-component, polymer modified, cementitious mortar containing a corrosion inhibitor.

a. Compressive strength

1) 5,500 psi at 28 days using 2 inch cubes, per ASTM C109.

b. Flexural Strength

1) 600 psi at 28 days, per ASTM C348

c. Bond Strength

1) 1800 psi at 28 days, per ASTM C882

d. Products

1) Master Builders Soltuions "MasterEmaco N 400"

2) Euclid "Eucorepair V100" or "Tamms Structural Mortar"

3) Sika "SikaTop 123 Plus

e. Bonding agent

1) Repair mortar scrub coat per manufacturer's instructions

G. Vertical Repairs, Form and Pour, Thickness 6 Inches or Less

1. One-component, cementitious material containing a corrosion inhibitor. Shrikage compensated or polymer modified.

a. Compressive strength

1) 6,500 psi at 28 days using 2 inch cubes, per ASTM C109.

b. Flexural Strength

1) 770 psi at 28 days, per ASTM C348

c. Bond Strength

1) 2500 psi at 28 days, per ASTM C882

d. Rapid Chloride Permeability

1) Maximum 650 coulombs at 28 days, per ASTM C1202

e. Products

1) Master Builders Solutions "MasterEmaco S 466Cl"

2) Euclid "Eucorepair SCC Fast"

3) Sika "Sikacrete 211 SCC Plus"

f. Bonding agent

1) Extended open time type; three component, epoxy modified, with corrosion inhibitor, minimum bond strength of 2000 psi at 7 days per ASTM C882.

a) Master Builders Solutions "MasterEmaco P 124"

b) Euclid "Duralprep A.C."

c) Sika "Armatec 110 EpoCem"

H. Vertical Repairs, Thickness Greater Than 6 Inches

1. Cast-in-place concrete, per the concrete specification.

a. Bonding agent

1) Extended open time type; three component, epoxy modified, with corrosion inhibitor, minimum bond strength of 2000 psi at 7 days per ASTM C882.

a) Master Builders Solutions "MasterEmaco P 124"

b) Euclid "Duralprep A.C."

c) Sika "Armatec 110 EpoCem"

b. Water

1) Clean and free from deleterious substances.

I. Reinforcement Anti-Corrosion Coating

1. Extended open time type; three component, epoxy modified, with corrosion inhibitor, minimum bond strength of 2000 psi at 7 days per ASTM C882.

a. Master Builders Solutions "MasterEmaco P 124"

b. Euclid "Duralprep A.C."

c. Sika "Armatec 110 EpoCem"

J. Penetrating Sealer

1. Silane-based sealer with minimum 40% active ingredient. Minimum water repellency of 85% by ASTM C642.

a. Master Builders Solutions "MasterProtect H 400"

b. Euclid "Baracada Silane 40 WB"

c. Sika "Sikagard 740 W"

K. Coarse Aggregate Extension of Cementitious Mortar

1. In areas where depth of repair exceeds manufacturer's recommended limits for neat repair mortar, repair mortar may be extended with washed, graded, rounded, high-density, low-absorption coarse aggregate meeting ASTM C33. Aggregate shall be in size and volumes recommended by the product manufacturer. Aggregate extension shall not be permitted unless approved by ENGINEER.

PART III - EXECUTION

3.01 GENERAL

A. Unless otherwise specified, all materials shall be prepared and applied in strict accordance with the manufacturer's printed installation instructions.

3.02 INSPECTION

A. Prior to the placement of repair material, the surface to be repaired shall be inspected by the material manufacturer's field representative to assure the surface conditions are correct for the type of repair and the material is being used as specified.

3.03 PREPARATION

A. The following instructions serve as general guidance only. For product-specific procedures, refer to the manufacturer's instructions of selected products. In case of discrepancy, follow manufacturer's literature.

1. Cleaning

   a. The surface of existing concrete shall be clean and the pores free of any dirt or material that will be detrimental to the bond of the repair material. All oil, dirt, debris, paint, and unsound concrete shall be removed. Cleaning shall include complete removal of all dust, dirt, and residue by high pressure washing.

2. Surface Preparation

   a. All prepared surfaces shall conform to the requirements of the material manufacturer. All edges shall be square cut to avoid feather edges. As required, surfaces shall be prepared mechanically using a scabbler, bushhammer, chipping hammer, shotblast, scarifier or hydrodemolition equipment which will give the specified surface profile. Means and methods selected, subject to acceptance by ENGINEER, shall minimize surface micro-cracking (i.e. "bruising") and impact on areas surrounding the Work area. CONTRACTOR shall provide a minimum Concrete Surface Profile (CSP) equal to that recommended by the material manufacturer.

   b. Remove all loose and unsound concrete per International Concrete Repair Institute (ICRI) Guideline 310.1R "Guide for Surface Preparation." Repair areas shall be sawcut around the perimeter in a square or rectangular shape. For thin repairs of 1/4 inch or less, the saw cut depth shall not exceed 1/4 inch deep. For thicker repairs, the saw cut depth shall be a minimum of one-half inch but shall be limited to prevent the saw from damaging embedded reinforcement. Saw cuts shall be made perpendicular to the concrete surface and all concrete removal boundaries shall be straight.

c. Concrete shall be removed within repair boundaries to depth that is as uniform as practicable, and within the minimum and maximum layer thicknesses recommended by the material manufacturer. Exposed concrete surfaces shall be visually examined and tested with a mason's hammer to confirm soundness of the base material. If delamination, cracking, or otherwise unsound material exists, CONTRACTOR shall notify ENGINEER for direction before continuing with the work.

3. Cracks

   a. Cracks shall be located and repaired, if required, in accordance with the Concrete Crack Repair specification. All cracks located within or adjacent to Work covered under this specification shall be repaired prior to performance of the Work covered under this specification.

   b. After cleaning of the concrete surface in accordance with, 3.3 A, cracks that are located are to be evaluated. Cracks that meet the following conditions are to be repaired per this specification:

      1) If the crack is equal or greater than 0.03" (0.75 mm) in width.

      2) If the CONTRACTOR considers the crack to be of structural significance, it shall be brought to the ENGINEER's attention for evaluation.

4. Inspection and Replacement of Reinforcement

   a. If reinforcement is exposed so that more than half the circumference of the bar is visible, the remaining concrete shall be removed to provide 1 inch of clear space all around the bar.

   b. Reinforcement that has lost more than 20 percent of its original cross-sectional area shall be repaired by adding new reinforcement. The new reinforcement shall be spliced or connected to the existing reinforcement on both ends of the damaged portion of the original bar. Splices shall be Class B, and mechanical connectors shall be ACI 318 Type 2.

   c. CONTRACTOR shall clean all exposed reinforcing steel to a bare metal finish prior to installation of repair materials.

   d. Repaired reinforcement shall be inspected by ENGINEER or OWNER's representative prior to placement of concrete repair materials.

3.04 APPLICATION

A. Concrete repair work shall be performed in accordance with the following requirements.

B. Bonding and Priming

1. Bonding agent shall be applied per manufacturer's recommendations. The manufacturer's coverage rate shall be followed. For rough surfaces, scrub bonding agent into the surface with a stiff broom.

2. Apply all prepackaged bonding agent materials within recommended ambient and substrate temperatures published in the manufacturer's printed installation instructions. Materials shall not be applied over frozen or liquid filled surfaces.

3. Upon completion of all concrete and reinforcing steel demolition, surface preparation, and cleaning operations, apply specified bonding agent to substrate. Provide complete and thorough coverage of surface assuring that bonding agent has been fully worked into profile of surface.

4. For repair mortar scrub coat bonding agents, the concrete surface shall be saturated with water one hour prior to placement of the scrub coat to provide a saturated substrate. Just prior to application of the scrub coat, water shall be removed by compressed air blasting. Compressed air shall be maintained free of oil and contaminants by filtration as needed. The mortar scrub coat shall be wet and not yet stiffened when repair material is applied.

5. For extended open time bonding agents, mix bonding agent and apply two uniform coats at manufacturer's published recommended coverage rates to properly prepared surfaces. Allow adequate time between coats per manufacturer's recommendations. The repair material shall be applied within the allowable open time of the bonding agent.

C. Treatment of Reinforcement and Other Metal Embedments

1. All existing and new reinforcement shall be secured and properly positioned by tying to other secured bars or supplemental anchoring pins as needed.

2. All exposed reinforcement and other metal embedments within the repair area shall be treated with two coats of anti-corrosion coating.

D. Forming

1. Forms shall be water-tight and constructed with sufficient rigidity to withstand head pressure and prevent excessive deflection during material placement. For pumped applications without open top forms, provide a port connection or birdmouth of sufficient size to allow pumping into the form. After forms are removed, all birdmouths and other protrusions resulting from the placement method shall be carefully removed and the surface smoothed.

2. Tolerances for formed work shall be as stipulated in ACI 117 for cast-in-place concrete, unless otherwise indicated. Formed surfaces shall meet Class C requirements for both abrupt and gradual irregularities.

E. Shoring and Support

1. When removal and repair of deteriorated concrete may cause temporary weakness, excessive deflections, structural instability, or other unacceptable damage, shoring or other suitable supports shall be provided until completion of the repair work is complete and the material has reached its design compressive strength.

F. Cold Weather Conditions

1. Repair materials shall not be applied without protection in temperatures below 45 degrees F, nor when the temperature is expected to fall below 45 degrees F during the curing period, unless more stringent requirements are provided by the material manufacturer's printed installation instructions.

3.05 FINISHING

A. All surfaces shall be finished to match the surrounding concrete.

3.06 CURING

A. The following instructions serve as general guidance only. For product-specific procedures, refer to the manufacturer's instructions of selected products. In case of discrepancy, follow manufacturer's literature.

B. General

1. Immediately following placement and finishing procedures, cure cementitious repair mortars for a duration as instructed by manufacturer's instructions. Curing procedures shall be in accordance with ACI 308.1 and the manufacturer's printed installation instructions. The more stringent requirements shall control.

2. When ambient temperatures below 45 degrees F are expected during the curing period, the repair material shall be maintained at 50 degrees F for the full period. Sudden cooling shall not be permitted. Gradual temperature drop shall be maintained at not more than 20 degrees F in any 24 hour period. Carbon dioxide or exhaust gases from combustion heaters shall not be allowed within enclosures or allowed to contact the repair material. Repair materials shall not be exposed to freezing temperatures until at least 24 hours after the end of the curing period..

3. Unless specified otherwise, one or more of the following methods shall be used:

C. Water Curing

1. Keep concrete surfaces continuously wet with water during the curing period. The method used shall limit water runoff and any runoff shall be directed and controlled. The difference in temperature between the water used for curing and the concrete surface shall not exceed 20 degrees.

D. Wet Coverings Curing

1. Cover the surfaces with moisture retaining curing blankets, burlap, cotton mats, or other suitable moisture retaining materials. The coverings shall not stain or otherwise discolor the repair material or the surrounding surfaces, and shall keep the repair products fully saturated during the curing period. Lap all coverings at least 8 inches at joints.

E. Membrane Curing

1. Membrane curing compounds shall only be used if the repair material manufacturer's printed installation instructions recommend a compound be used instead of water or wet coverings. Membrane curing compounds shall not be used on surfaces to receive a penetrating sealer.

3.07 SEALING

A. Provide a penetrating sealer over the concrete repair product when recommended by the repair product manufacturer, or when no other sealer is specified on the drawings or other specifications. The penetrating sealer shall be applied in accordance with the manufacturer's instructions.

3.08 FIELD QUALITY CONTROL

A. Material Storage and Handling

1. The material shall be delivered in original, unopened containers. Containers shall be labeled with the manufacturer's name, product name, and lot number. Materials shall be stored at the job site under dry conditions and at temperatures between 50 degrees F and 90 degrees F unless more stringent limitations are required by the manufacturer.

B. Protection

1. Repair areas shall be protected from other trades and weather for a minimum of 10 days after material is placed.

C. Cleaning

1. Work areas are to be cleaned each day. Upon completion of the final cleanup, CONTRACTOR shall restore all areas affected by repair procedures to their original condition, leaving no trace of material piles or other wasted materials.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This Section applies to all stainless steel fabrications as shown on the PLANS. Furnish all plant, labor, supervision, materials, equipment, supplies, tools, and all operations in connection with furnishing, installing, and placing in service stainless steel fabrications.

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCES

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

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

A167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
A240/A240M	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
A276	Standard Specification for Stainless Steel Bars and Shapes
A380/A380M	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
A967/A967M	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Section IX	Boiler and Pressure Vessel Code - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

B18.2.1	Square Hex, Heavy Hex, and Askew Head Bolts, and Hex, Heavy Hex, Hex Flange, Lobed Head, Lag Screws (Inch Series)

1.04 - 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submit the following in accordance with Specification Section 01300 "Submittals".

B. Furnish large-scale, dimensioned shop drawings showing plan, elevation, and appropriate cross sections. Show piece marks, sizes, drilling, thickness, joint details, and materials. Furnish chemical and physical material certificates for each heat used during manufacture.

C. Submit welder qualification certificates.

D. Submit shop testing certificates.

E. Submit pickling and passivation procedures and material descriptions.

1.07 QUALITY ASSURANCE

A. Fabrication dimensions and accuracy of fabrication are Contractor's responsibility.

B. Thoroughly clean any equipment before use in cleaning and fabrication of stainless steel.

1.08 DELIVERY, STORAGE AND HANDLING

A. Shipping

1. Ship factory fabricated assemblies in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.
2. Loose parts (nuts and bolts, etc.) are to be shipped in crates that are clearly marked as to contents.

B. Handling and Unloading

1. Unload and handle equipment in accordance with fabricator's instructions.
2. Transfer of unprotected stainless steel to be accomplished utilizing nylon straps or stainless steel cables to avoid contact with carbon steel components.

C. Storage

1. Store in an area that will avoid damage due to traffic.
2. Exposure to normal weather conditions is acceptable; however, avoid contact with other materials like carbon steel, aluminum, concrete, and corrosive chemicals.
3. Store materials to avoid contact with the ground.

1.09 - 1.11 (NOT USED)

PART II - PRODUCTS

2.01 MANUFACTURER(S)

A. Use materials of domestic manufacture.

2.02 MATERIALS AND/OR EQUIPMENT

A. General: Materials used in manufacture to be 316L stainless steel unless specifically noted otherwise.

B. Minimum Material Requirements

1. Stainless Steel Bars and Shapes: ASTM A276.
2. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, ASTM A240, or ASTM A167.
3. Stainless Steel Bolts and Nuts: ASTM 193.

2.03 FABRICATION

A. General

1. All fabrication to be performed in a fully equipped fabrication shop.
2. Each piece to be marked with an identification mark that corresponds to the shop drawing to facilitate job site assembly.

B. Welding

1. All welding is to be qualified and certified in accordance with the requirements of the latest edition of ANSI/AWS D1.1 "Structural Welding Code – Steel" published by the American Welding Society.
2. Fabricate utilizing inert argon gas, shielded arc plasma, MIG or TIG welding procedures.
3. Add filler wire to all welds to provide a cross sectional area of weld and metal thickness equal to or greater than the parent metal. Filler wire to be at least one grade higher than the parent metal and of the extra low carbon grade.
4. Rigid jigs and fixtures are to be utilized for holding parts together in proper alignment while welding.
5. All joints are to be accurately fitted, aligned, and cleaned of foreign material prior to welding.
6. Grind flush all welds on gasketed surfaces.

C. Pickle and passivate all welded stainless steel fabrications by using the following procedure.

1. Wire-brush all outside weld area to remove weld splatter. Brushes are to be stainless steel and are to have been used only on stainless steel.

2. Remove all carbon deposits, greases, and oils by pickling and neutralization to aid the regeneration of a uniform corrosion-resistant chromium oxide film.
   a. After welding and brushing the weld clean, completely immerse all stainless steel assemblies and parts in a pickling solution of 6% nitric acid and 3% hydrofluoric acid at a temperature of 140 F for a minimum of 15 minutes or until a mild etch is achieved. In lieu of passivation, a glass bead blast will be acceptable.
   b. Neutralize the pickling solution after cleaning by immersing the assemblies and parts into a solution of tri-sodium phosphate and then rinsing with clean water.

2.04 SOURCE QUALITY CONTROL

A. Nuts and Bolts: Per ANSI B 18.2, stainless steel, type and grade to prevent galling.

PART III -EXECUTION

3.01 - 3.02 (NOT USED)

3.03 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. General Requirements

1. PLANS show sizes, elevations, and general arrangement.

3.04 - 3.10 (NOT USED)

1.11 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This section includes the furnishing, fabrication, and installation of structural steel and shrinkage resistant grout.

1.02 RELATED REQUIREMENTS

A. Related work as called for on plans or specified elsewhere in this or other technical specification sections and as described in ANSI/AISC 303.

1.03 REFERENCES

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

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

A27/A27M	Standard Specifications for Steel Castings, Carbon for General Application
A36/A36M	Standard Specification for Carbon Structural Steel
A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless
A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A193/A193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Application
A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rods, 60,000 psi Tensile Strength
A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing or Steel Assemblies
A500/A500M	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A563/A563M	Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric)
A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A992/A992M	Standard Specification for Steel for Structural Shapes for Use in Building Framing
B29	Standard Specification for Refined Lead
B152/B152M	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
B187	Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes
B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
B308/B308M	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
F436/F436M	Standard Specification for Hardened Steel Washers (Inch and Metric)
F3125/F3125M	Standard Specification for High-Strength Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength
F959/F959M	Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.04-1.05 (NOT USED)

1.06 SUBMITTALS

A. Submit the following in accordance with Specification Sections 01300 "Submittals".

B. Shop Drawings

1. Required for structural steel, forgings, wrought iron, castings, or bearings.
2. Required for camber and erection diagrams.
3. Shop drawings to reflect use of submerged arc welding, gas metal arc welding, or cored arc welding.
4. Submit preliminary erection drawings showing sequence of erection, location of falsework, and location of ground and air splices.
5. Provide the following information for members fabricated by welding or bolting.
   a. Fabricating procedures.
   b. Calculated stresses.

c. List of equipment used for fabrication.
d. Sequence of assembly.
e. Details of connections.
f. Special processes such as planing, facing, etc.

6. Provide product data for all components.

C. Certificates

1. Submit certified copy of mill certificates of compliance with requirements herein specified for structural steel and other metals.
2. Submit certified copy of shop welding tests in compliance with requirements herein specified.
3. Welder certifications for all Field Welders when requested.
4. Mill tests not required for miscellaneous hardware, bolts, nuts, washers, screws, etc.

D. Welding: Equipment, procedures, operations, workmanship, qualification of welders, and inspection to conform with AISC and AWS.

1. Shop welding to be at no additional cost to OWNER.
   a. Make random radiographic inspections of 35 percent of primary welds.
   b. Welds requiring repairs to be retested by radiography after repairs are made.
   c. If defective work is found, make additional radiographs on sections welded by same equipment and/or operator just prior to and just after the section containing the defect.
   d. Radiography required because of unacceptable welding to be performed by approved commercial laboratory at no additional cost to OWNER.
2. Field Welding
   a. Make random radiographic inspections of all full penetration welds of beam flanges.
   b. Ultrasonic testing of all other full penetration welds.
   c. Visual inspection of all welds not specified to receive radiographic or Ultrasonic Testing.
   d. Radiograph defective weld repairs.
   e. Radiography required because of unacceptable welding to be performed by approved commercial laboratory at no additional cost to OWNER.

1.07 (NOT USED)

1.08 DELIVERY, STORAGE AND HANDLING

A. Handle material so as to prevent damage.

B. Store material on skids above ground and keep clean, properly drained, and protected from elements which cause corrosion or damage.

C. Store girders and beams upright and prevent excessive deflection.

1.09 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

PART II - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 360.
3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 1: Connection designs have been completed and connections indicated on the Drawings.
2. Option 2: Fabricator's experienced steel detailer selects or completes connections in accordance with ANSI/AISC 303.

    a. Select and complete connections using schematic details indicated and ANSI/AISC 360.
    b. Use Load and Resistance Factor Design; data are given at factored-load level.

3. Option 3 and 3A: Design connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer. Member reinforcement at connections is indicated on Drawings.

    a. Use Load and Resistance Factor Design; data are given at factored-load level.

4. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

a. Use Load and Resistance Factor Design; data are given at factored-load level.

C. Moment Connections: Type FR, fully restrained.

D. Construction: Combined system of moment frame and braced frame.

2.02 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.

B. Channels, Angles: ASTM A36/A36M.

C. Plate and Bar: ASTM A36/A36M.

D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

2.03 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with Hot Dip Galvanized finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with Zinc finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-1, compressible-washer type with plain finish.

2.04 RODS

A. Unheaded Anchor Rods: ASTM F1554, Grade 55, weldable.

1. Configuration: Straight.
2. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

B. Headed Anchor Rods: ASTM F1554, Grade 55, weldable, straight.

1. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

C. Threaded Rods: ASTM A193/A193M, Grade B7.

1. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C

2.05 PRIMER

A. Steel Primer:

1. Comply with Section 09902 "Painting and Protective Coatings"
2. SSPC-Paint 23, latex primer.
3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: MPI#26.

1. Etching Cleaner: MPI#25, for galvanized steel.
2. Galvanizing Repair Paint: ASTM A780/A780M.

2.07 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.08 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

B. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

2.09 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.10 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.11 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.
4. SSPC-SP 6 (WAB)/NACE WAB-3.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165/E165M.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M.
5. Prepare test and inspection reports.

PART III - EXECUTION

3.01 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonrybearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonrybearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

3.03 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1) Liquid Penetrant Inspection: ASTM E165/E165M.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3) Ultrasonic Inspection: ASTM E164.
4) Radiographic Inspection: ASTM E94/E94M.

3.05 - 3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This Section includes the furnishing, fabrication, and installation of various metals for various types of structures shown on plans.

B. Section Includes:

1. Miscellaneous framing and supports.
2. Metal ladders.
3. Metal floor plate.
4. Structural-steel door frames.
5. Miscellaneous steel trim.
6. Metal bollards.
7. Abrasive metal nosings, treads, and thresholds.
8. Loose bearing and leveling plates.

C. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete.

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCES

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

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

ASTM A27/A27M	Standard Specifications for Steel Castings, Carbon for General Application
A36	Standard Specification for Carbon Structural Steel
A48	Standard Specification for Gray Iron Castings
A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A193/A193M	Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Application
A276/A276M	Standard Specification for Stainless Steel Bars and Shapes
A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rods, 60,000 psi Tensile Strength
A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing or Steel Assemblies
A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
A786/A786M	Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
A992/A992M	Standard Specification for Steel for Structural Shapes for Use in Building Framing
A741	Standard Specification for Metallic-Coated Steel Wire Rope and Fittings for Highway Guardrail
A492	Standard Specification for Stainless Steel Rope Wire
B26/B26M	Standard Specification for Aluminum-Alloy Sand Castings
B632/B632M	Standard Specification for Aluminum-Alloy Rolled Tread Plate
B152/B152M	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
B187	Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes
B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
B308/B308M	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

B455	Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes
F3125/F3125M	Standard Specification for High-Strength Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength
B584	Standard Specification for Copper Alloy Sand Castings for General Applications

1.04-1.05 (NOT USED)

1.06 SUBMITTALS

A. Submit the following in accordance with Specification Sections 01300 "Submittals".

1. Product data for all components
2. Shop drawings to define fabrication and installation details.

1.07 QUALITY ASSURANCE

A. Fabrication dimensions and accuracy of fabrication are contractor's responsibility.

1.08 DELIVERY, STORAGE AND HANDLING

A. Handle material so as to prevent damage.

B. Store material on skids above ground and keep clean, properly drained, and protected from elements which cause corrosion or damage.

1.09-1.11 NOT USED)

PART II - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance of Ladders: Ladders, including landings, are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

2.02 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/A36M.

C. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 316L.

D. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

E. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

F. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

G. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

H. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

I. Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.

1. Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

J. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

K. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

L. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

M. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

N. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

O. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).

P. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.03 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/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum or stainless steel.
2. Provide bronze fasteners for fastening bronze.

B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

C. Post-Installed Anchors: chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, 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.

D. 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.

2.04 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 09902 “Painting and Protective Coatings”.

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 that contains 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/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in City of Austin specification 403S.

2.05 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. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.

2.06 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.

C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches o.c.

D. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.07 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with zinc-rich primer.

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.08 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails 18 inches apart unless otherwise indicated.
2. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
3. Rungs: 1-inch-diameter, steel bars.
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.
6. Galvanize exterior ladders, including brackets.

C. Aluminum Ladders:

1. Space siderails 18 inches apart unless otherwise indicated.
2. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
3. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.

2.09 METAL FLOOR PLATE

A. Fabricate from rolled-steel floor plate of thickness indicated below:

1. Thickness: 1/2 inch.

B. Provide steel angle supports as indicated.

C. Provide flush steel 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. 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. Galvanized, stainless, or aluminum steel frames.

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. Galvanized, stainless, or aluminum exterior miscellaneous steel trim.

2.12 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

1. Cap bollards with 1/4-inch-thick steel.

B. Fabricate bollards with 3/8-inch-thick, steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

C. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe or tubing with 1/4-inch-thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

D. Prime steel bollards with zinc-rich primer.

2.13 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

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.

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.

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.

E. Apply bituminous paint to concealed surfaces of cast-metal units.

F. Apply clear lacquer to concealed surfaces of extruded units.

2.14 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 bearing and leveling plates.

C. Prime plates with zinc-rich primer.

2.15 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Galvanize loose steel lintels located in exterior walls.

2.16 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.

2.17 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

2.18 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. 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 unless zinc-rich primer is indicated.

C. 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 Section 09903 "Painting and Protective Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

D. 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 III - EXECUTION

3.01 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.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. 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 operable partitions overhead doors and overhead grilles securely to, and rigidly brace from, building structure.

C. Anchor shelf angles securely to existing construction with anchor bolts.

D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

3.03 INSTALLATION OF SHELF ANGLES

A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

3.04 INSTALLATION OF METAL LADDERS

A. Secure ladders to adjacent construction with the clip angles attached to the stringer.

B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.05 INSTALLATION OF METAL FLOOR PLATE

A. Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.06 INSTALLATION OF STRUCTURAL STEEL

A. Fasten structural steel door frames to the floor slab by means of angle clips and expansion bolts. Anchor door jambs to adjacent construction in accordance with shop drawing details.

3.07 INSTALLATION OF MISCELLANEOUS STEEL TRIM

A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.08 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards to existing construction with anchor bolts. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

C. Anchor bollards in concrete in formed or core-drilled holes not less than 42 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Fill bollards solidly with concrete, mounding top surface to shed water.

3.09 INSTALLATION OF ABRASIVE METAL NOSINGS, TREADS, 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 07902 "Sealants" to provide a watertight installation.

3.10 INSTALLATION OF LOOSE 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 shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.11 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 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/A780M.

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This Section includes the fabrication, furnishing, and installation of aluminum handrails, complete in place, at locations shown on PLANS.

1.02 (NOT USED)

1.03 REFERENCES

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

ALUMINUM ASSOCIATION (AA)

ASD-1	Aluminum Standards and Data
DAF-45	Designation System for Aluminum Finishes
SAA-46	Standards for Anodized Architectural Aluminum

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

A193/A193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
B429	Standard Specification for Aluminum Alloy Extruded Structural Pipe and Tube
F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

AMERICAN WELDING SOCIETY (AWS)

D1.2	Structural Welding Code Aluminum

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

29 CFR 1910	OSHA Regulation Safety and Health Standards for General Industry

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

UBC	Uniform Building Code

1.04 DEFINITIONS

A. PLANS use the terms handrail and guardrail to refer to the railing system defined by this Specification and standard detail drawings.

1.05 (NOT USED)

1.06 SUBMITTALS

A. Submit the following in accordance with Specification Section 01300 "Submittals".

B. Product data for materials used.

C. Complete shop drawings showing handrail locations, railings, posts, splice locations and expansion joint locations. Also include manufacturer's details for connections, anchorage, splices, expansion joints, gates and other pertinent data.

D. Design calculations showing that the material meets or exceeds the allowable working stress under the applied loading conditions. Test reports may be used to complement the design calculations. Design calculations to be sealed by a Professional Engineer licensed in the State of Texas.

E. Field layout of fabricated sections to ensure proper fit during erection, after fabrication and finishing, and prior to shipment.

F. Certificate of Conformance as required in Paragraph 1.07 - Quality Assurance.

1.07 QUALITY ASSURANCE

A. All design computations and detailed drawings are to be prepared by or under the direct supervision of a Professional Engineer licensed in the State of Texas. Provide a certificate signed and sealed by same engineer stating that the computations and drawings are in conformance with specified design criteria.

B. Provide handrail system complying with Uniform Building Code and OSHA Regulations.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver handrail to jobsite with sufficient protection to ensure arrival in acceptable and undamaged condition.

B. Store handrail on level supports above ground, not in contact with dissimilar metals. Protect to prevent damage and exposure from elements until erected. Replace or repair damaged sections at no additional cost to OWNER.

1.09 - 1.11 (NOT USED)

PART II - PRODUCTS

2.01 MANUFACTURER(S)

A. Manufacturer: Products of the following manufacturers, provided they comply with requirements of the Contract Documents, will be among those considered acceptable, or an approved equal.

1. Hollaender Railing Systems (Interna-Rail).
2. Thompson Fabricating Co. (TUFrail).

2.02 MATERIALS AND/OR EQUIPMENT

A. General

1. Handrail shall be the product of a company normally engaged in the manufacture of pipe railing.
2. Handrail shall conform to requirements of OSHA 1910.23 and applicable building code. Local building code in Austin, TX is the Uniform Building Code.
3. Handrail and posts to be fabricated from 1½-inch nominal diameter 6063-T6 or 6061-T6 aluminum pipe, Schedule 40 minimum conforming to ASTM B429. Exposed aluminum surface to be 0.7-mil thick clear anodized finish, per Aluminum Association Designation M43C22A41.
4. Handrail to be 42 inches high; stair handrail to be 34 inches high, unless other¬wise noted on PLANS. Centerlines of posts and handrails to be in same plane. Locate intermediate rails as shown on PLANS.
5. Unless shown otherwise in PLANS, post spacing not to exceed 5 feet for horizontal handrail and 4 feet for stair handrail (measured horizontally). The manufacturer must reduce the post spacing and/or add dowels, as required to meet the loading requirements.
6. Provide a 4-inch-high extruded aluminum toe plate that attaches to the posts with clamps that will allow for horizontal expansion and contraction between posts. Toe plate to have not more than 1/4-inch clearance above floor level, and provided on all walkways and stair landings. Provide notch in toe plate at post as required to maintain specified clearance.
7. Handrail system, which consists of three horizontal rail members, posts, connections and anchorages, shall be designed to withstand a 200-pound concentrated load applied at any point and in any direction or a 50 lb./ft. uniform load applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently. The posts and associated floor flange anchorage shall be designed to withstand a 200-pound concentrated load applied at the top rail.
8. Provide expansion joint splices in all rails of handrail and toe board at not greater than 20 feet spacing and at expansion joints in concrete structure. Minimum projection of expansion splice inside adjacent pipe shall be 1½”.

9. Splices and expansion joints in the railing system components shall be located within 8 inches of posts or other railing system supports.
10. Provide 1/4-inch weep holes at low points in all handrails and posts to prevent trapping of moisture.
11. Removable handrail to have vertical pipe supports fastened as shown on PLANS. Unless otherwise indicated, fabricate removable handrail in unit sections not exceeding 10 feet long with at least three vertical supports, including one at each end.
12. Handrails attached to load-bearing walls to be mounted with aluminum or stainless steel brackets. Fasten each bracket with a minimum 3/8-inch diameter Type 316 stainless steel expansion bolt set into the wall and tapped into bracket. Bracket to have a 3-inch projection from wall and be uniformly spaced approximately 4 feet with the end brackets not more than 12 inches from the ends of the handrails.
13. Posts and rails to be continuous throughout their sectional lengths. Curved members to be formed to true radii, free from dye marks or surface abrasions. Furnish handrail in shop fabricated sections, complete with accessories, including gates, hardware, closure caps for rail terminations, base trim, and anchorages.
14. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations (OSHA 1910.23). The top surface of the top railing shall be smooth and shall not be interrupted by a projecting fitting.
15. Aluminum surfaces in contact with concrete, grout or dissimilar metals will be protected with a mylar isolator, bituminous paint or other approved material.
16. Handrail system posts are to be anchored to concrete structures with Type 316 stainless steel bolts. Bolts and floor flange shall be designed to resist a 200-pound load applied horizontally to the top rail. Bolt manufacturer's published shear and pullout values shall be reduced for spacing and edge distance conditions as shown on plans.
17. Safety Chains: Construct safety chains of stainless steel, straight link type, 3/16-inch diameter, with at least twelve links per foot, and with boat type snap hooks on each end. Provide S.S. 3/8-inch bolt with 3/4 -inch eye diameter for attachment of chain, anchored as indicated. Supply a minimum of two chains or as noted on PLANS, 4 inches longer than the anchorage spacing, for each guarded area. Locate safety chain where indicated.

B. Nonwelded Aluminum Handrails

1. Fittings to be extruded or cast aluminum, 6063 Aluminum Alloy with a minimum 0.4-mil thick clear anodized finish per Aluminum Association Designation M43C22A4l.
2. The handrail shall be made of pipes joined together with component fittings. Components that are glued or pop-riveted at the joints will not be acceptable. All components must be mechanically fastened with stainless steel hardware.

3. Fitting shall be an internal double-prong expandable fitting that is activated by a stainless steel or aluminum set screw. The fitting shall be externally connected to the pipe by means of an anodized aluminum tubular rivet nut, and stainless steel socket head cap screw. All fittings, elbows, wall returns, and caps to be flush-type. Exposed fasteners to be set flush or recessed. All fasteners to be Type 316 stainless steel.
4. Unless otherwise noted on PLANS, all handrails to be nonwelded aluminum.

C. Welded Aluminum Handrail

1. Handrail and posts to be joined by welding only if indicated on PLANS. Welding to consist of flush-type weld fittings or coping of pipe ends to conform with adjoining pipe and welding. Welds to be ground smooth and flush.
2. Elbows, capped terminations, and wall returns to be formed by flush fittings. Secure rails terminating against masonry or concrete with flanged fittings and anchor bolts.

2.03 FABRICATION

A. Furnish railings in shop-fabricated sections, complete with accessories, including gates, plated hardware, closure caps for rail termination, base trim, and anchorages.

2.04 (NOT USED)

PART III - EXECUTION

3.01- 3.02 (NOT USED)

3.03 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Handrail to be installed by fabricator in strict compliance with fabricator's instructions. Install handrail plumb and within a tolerance of 1/4-inch maximum deviation either side of the longitudinal centerline. Cuts to be clean and straight, free from burrs and nicks.

B. Posts embedded in concrete to be set in sleeves with quick-setting non-shrink grout.

C. Install removable and permanent handrail units with bolted floor type flanges.

D. Use of shims, washers, wedges, or similar devices are not allowed when plumbing or aligning handrail.

3.04 - 3.10 (NOT USED)

3.05 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This Section includes the furnishing, fabrication and installation of aluminum gratings of the sizes indicated on the PLANS.

1.02 (NOT USED)

1.03 REFERENCES

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

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Projects
B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
D 1187-97	Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal

AMERICAN WELDING SOCIETY (AWS)

D1.2	Structural Welding Code - Aluminum

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

ANSI/NAAMM MBG 531	Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads
NAAMM AMP 500/505	Metal Finishes Manual for Architectural and Metal Products

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC-Paint 12	Paint Specification No. 12: Cold-Applied Asphalt Mastic (Extra Thick Film)

1.04 - 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submit the following in accordance with Specification Section 01300 "Submittals".

B. Manufacturer's product data for grating, clips, and anchorage devices to be used.

C. Completed shop drawings showing sizes, fabrication, anchorage, metal gauges, reinforcement, finishes, layouts including direction of span and other pertinent data.

1.07 QUALITY ASSURANCE

A. Field measurements of previously installed construction shall be indicated on shop drawings prior to submittal to ENGINEER for review.

B. After fabrication, finishing, and prior to shipment, manufacturer to assemble in the shop the grating and accessories to assure proper fit, alignment, and bundling in sequence of erection.

C. Metal Bar Grating shall comply with ANSI/NAAMM MBG 531-00 "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."

D. Qualify welding procedures and personnel according to the following:

1. AWS D1.2 "Structural Welding Code - Aluminum".

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver grating and accessories to jobsite storage area with sufficient protection, bracing, etc., to ensure undamaged condition.

B. Store in original bundles on level supports to protect from damage.

1.09 - 1.11 (NOT USED)

PART II - PRODUCTS

2.01 MANUFACTURER(S)

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Aluminum Bar Gratings (or equivalent as approved by EOR)
   a. McNichols Co.
   b. IKG Borden
   c. Ohio Gratings, Inc.
   d. Fisher and Ludlow

2.02 MATERIALS AND/OR EQUIPMENT

A. Aluminum Extruded Bars and Shapes: ASTM B 221, alloys as follows:

1. Alloy 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. Alloy 6061-T1, for grating crossbars.

B. Bituminous Paint: Cold-applied asphalt mastic complying with SSPS-Paint 12, except containing no asbestos fibers, or cold-applied emulsion complying with ASTM D 1187.

C. Fasteners for Aluminum Gratings: Provide fasteners of aluminum, nonmagnetic stainless steel, zinc-plated steel, or other material warranted by the manufacturer to be compatible with aluminum gratings and other components.

2.03 FABRICATION

A. Fabricate pressure-locked, I-bar aluminum gratings as follows:

1. Grating Mark P-19-4 (1-3/4 I-Bar) ALUMINUM: 1-3/4-inch I-bar bearing bars at 1-3/16-inches o.c., and crossbars at 4 inches o.c.
2. Grating Mark P-19-4 (2-1/4 I-Bar) ALUMINUM: 2-1/4-inch I-bar bearing bars at 1-3/16-inches o.c., and crossbars at 4 inches o.c.
3. Provide sizes as indicated on PLANS.

B. Traffic Surface for Aluminum Bar Gratings: Grooved.

C. Fabricate openings in grating sections for penetrations indicated on PLANS as follows:

1. Layout grating panels to permit grating removal at cutouts without disturbing items penetrating grating.
2. Provide removable clips or bolts to attach adjacent grating panels next to cutouts.
3. Provide load-bearing edge-band openings in grating that interrupt four or more bearing bars. Edge-band bars shall be provided, designed, and detailed to distribute design loads from interrupted bearing bars to adjacent, uninterrupted bearing bears.
4. Cutouts for circular obstructions are to be 2 inches larger in diameter than the obstruction.
5. The minimum grating panel width adjacent to cutouts shall be 12 inches.

D. Removable grating: Where indicated on PLANS, fabricate removable grating sections with banding bars attached to the entire perimeter of each section. Provide not less than four anchoring devices for each removable grating section, as recommended by manufacturer for attaching to supports.

E. Finishes: Aluminum finishes shall comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

2.04 SOURCE QUALITY CONTROL

A. All grating and accessories are to be furnished by the same manufacturer.

PART III - EXECUTION

3.01 - 3.02 (NOT USED)

3.03 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Installation of grating to be as shown on PLANS, per grating manufacturer's recommendations, and per ANSI/NAAMM MBG 531-00.

B. Installation clips and field drilled holes for bolts to be per manufacturer's recommendations.

C. Bituminous paint shall be applied to all aluminum grating surfaces in contact with grout, concrete, masonry, wood, or dissimilar metals.

3.04 - 3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This section includes the furnishing, fabrication, and installation of metal bar gratings, grating frames, and supports of the sizes indicated on plans.

1.02 (NOT USED)

1.03 REFERENCES

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

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

A36/A36M	Standard Specification for Carbon Structural Steel
A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Projects
A153	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Hardware
A240/A240M	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
A276/A276M	Standard Specification for Stainless Steel Bars and Shapes
A510/A510M	Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

AMERICAN WELDING SOCIETY (AWS)

D1.1	Structural Welding Code—Steel
D1.3	Structural Welding Code—Sheet Steel
D1.6	Structural Welding Code—Stainless Steel

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

ANSI/NAAMM MBG 531	Metal Bar Grating Manual for Steel, Stainless Steel, Aluminum Gratings, and Stair Treads
ANSI/NAAMM 500/505	Metal Finishes Manual for Architectural and Metal Products

STEEL STRUCTURES PAINTING COUNCIL (AWWA)

SSPC-Paint 12	Paint Specification No. 12: Cold-Applied Asphalt Mastic (Extra Thick Film)

1.04-1.05 (NOT USED)

1.06 SUBMITTALS

A. Submit the following in accordance with Specification Section 01300 "Submittals".

B. Manufacturer's product data for grating, clips, and anchorage devices to be used.

C. Completed shop drawings showing sizes, fabrication, anchorage, metal gauges, reinforcement, finishes, layouts including direction of span including manufacturers' published load tables and other pertinent data.

1.07 QUALITY ASSURANCE

A. Field measurements of previously installed construction shall be indicated on shop drawings prior to submittal to ENGINEER for review.

B. After fabrication, finishing, and prior to shipment, manufacturer to assemble in the shop the grating and accessories to assure proper fit, alignment, and bundling in sequence of erection.

C. Metal Bar Grating shall comply with ANSI/NAAMM MBG 531-00 "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."

D. Qualify welding procedures and personnel according to AWS.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver grating and accessories to jobsite storage area with sufficient protection, bracing, etc., to ensure undamaged condition.

B. Store in original bundles on level supports to protect from damage.

PART II - PRODUCTS

2.01 MANUFACTURERS

2.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors for Light Manufacturing: Uniform load of 125 lbf/sq. ft. or concentrated load of 2000 lbf, whichever produces the greater stress.
2. Floors for Heavy Manufacturing: Uniform load of 250 lbf/sq. ft. or concentrated load of 3000 lbf, whichever produces the greater stress.
3. Walkways and Elevated Platforms Other Than Exits: Uniform load of 100 lbf/sq. ft..
4. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft..
5. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. or concentrated load of 8000 lbf, whichever produces the greater stress.
6. Limit deflection to L/360 or 1/4 inch, whichever is less.

2.03 METAL BAR GRATINGS

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531 and NAAMM MBG 532.

B. Welded Steel Grating:

1. Bearing Bar Spacing: 7/16 or 1/2 inch o.c.
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Plain.
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 Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.

1. Bearing Bar Spacing: 7/16 or 1/2 inch o.c.
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 4 inches o.c.

5. Traffic Surface: Plain.
6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

D. 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: 7/16 or 1/2 inch o.c.
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Plain.
6. Finish: Abrasive blasted.

2.04 GRATING FRAMES AND SUPPORTS

A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

B. Galvanize steel frames and supports as shown on drawings.

2.05 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use or zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening stainless steel.
2. Provide galvanized or zinc coated fasteners for fastening to galvanized steel.

B. Post-Installed Anchors: chemical 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 in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

2.06 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.07 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.

D. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30.

E. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33, with G90 coating.

F. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M, Type 316L.

G. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 316L.

2.08 (NOT USED)

2.09 FABRICATION

A. 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.

B. Fit exposed connections accurately together to form hairline joints.

2.10 (NOT USED)

2.11 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

C. Shop prime gratings, frames, and supports not indicated to be galvanized unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with 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 III - EXECUTION

3.01 INSTALLATION, GENERAL

A. 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.

B. 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.

C. Corrosion Protection: With a heavy coat of bituminous paint, coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals.

3.02 INSTALLATION OF METAL BAR GRATINGS

A. 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.

3.03 REPAIR

A. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

3.04-3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Miscellaneous framing and sheathing.

2. Concealed wood blocking for support of wall cabinets.

1.02 RELATED REQUIREMENTS

A. Section 08110 – Steel Doors and Frames: Door openings to receive wood blocking.

B. Section 08410 – Metal Framed Storefronts: Openings to receive wood blocking.

C. Section 09260 – Gypsum Board Assemblies: Framed partitions in which blocking support is added.

D. Section 12346 – Laboratory Work Surfaces: Casework counter in which blocking support/securement is added.

E. Section 12355 – Metal Laboratory Casework: Casework supported/secured by wood blocking of this section.

1.03 REFERENCE STANDARDS

A. American National Standards Institute / American Hardboard Association:

1. ANSI/AHA A135.4 - Basic Hardboard.

B. American Wood Protection Association:

1. AWPA M4 - Standard for the Care of Preservative-Treated Wood Products.

2. AWPA U1 - Use Category System: User Specification for Treated Wood.

C. APA - The Engineered Wood Association:

1. APA - Plywood Design Specification, including supplements.

2. APA AFG-01 - Adhesives for Field-Gluing Plywood to Wood Framing.

3. APA PS 1 - Voluntary Product Standard - Structural Plywood.

D. ASTM International:

1. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

2. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

3. ASTM C1177 - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.

4. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.

5. ASTM C1396 - Standard Specification for Gypsum Board.

6. ASTM D2559 - Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions.

7. ASTM D3498 - Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems.

8. ASTM D5456 - Standard Specification for Evaluation of Structural Composite Lumber Products.

9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

10. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

11. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

E. California Department of Health Care Services:

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

F. Forest Stewardship Council:

1. FSC Guidelines.

G. Green Seal:

1. GS-36 - Green Seal Standard for Adhesives for Commercial Use.

H. National Lumber Grades Authority:

1. NLGA - Standard Grading Rules for Canadian Lumber.

I. Northeastern Lumber Manufacturers Association:

1. NELMA - Standard Grading Rules for Northeastern Lumber.

J. Redwood Inspection Service:

1. RIS - Standard Specifications for Grades of California Redwood Lumber.

K. South Coast Air Quality Management District:

1. SCAQMD Rule 1168 - Adhesive and Sealant Applications.

L. Southern Pine Inspection Bureau:

1. SPIB - Standard Grading Rules for Southern Pine Lumber.

M. U.S. Department of Commerce National Institute of Standards and Technology:

1. DOC PS 1 - Structural Plywood.

2. DOC PS 2 - Performance Standard for Wood-Based Structural-Use Panels.

3. DOC PS 20 - American Softwood Lumber Standard.

N. West Coast Lumber Inspection Bureau:

1. WCLIB Standard 17 - Grading Rules for West Coast Lumber.

O. Western Wood Products Association:

1. WWPA - Western Lumber Grading Rules.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit manufacturer information on insulated sheathing, wood preservative materials, and application instructions.

C. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify that following products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

2) Certify that lumber is harvested from Forest Stewardship Council Certified well-managed forest.

b. Indoor Air Quality Certificates:

1) Certify VOC content for each interior adhesive and sealant and related primer.

2) Certify each composite wood product contains no added urea formaldehyde resins.

3. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

a. Provide cost data for following products:

1) Products with recycled material content.

2) Regional products.

3) Certified wood products.

1.07 COORDINATION

A. Section 01310 – Schedules and Reports: Requirements for coordination.

1.08 QUALITY ASSURANCE

A. Perform Work according to:

1. Lumber Grading Agency: Certified by DOC PS 20.

2. Wood Structural Panel Grading Agency: Certified by APA - The Engineered Wood Association.

3. Lumber: DOC PS 20.

4. Wood Structural Panels: DOC PS

B. Surface-Burning Characteristics:

1. Fire-Retardant-Treated Materials: Maximum 25/450 flame-spread/smoke-developed index when tested according to ASTM E84.

C. Apply label from agency approved by authority having jurisdiction to identify each preservative-treated and fire-retardant-treated material.

1.09 NOT USED

1.10 NOT USED

1.11 NOT USED

PART 2 - PRODUCTS

2.01 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2. Certified Wood Materials: Furnish wood materials certified according to FSC standards.

C. Indoor Environmental Quality Characteristics:

1. Interior Adhesives: Maximum VOC content according to SCAQMD Rule 1168.

2. Interior Aerosol Adhesives: Maximum VOC content according to GS-36.

3. Interior Composite Wood Products: Contain no added urea formaldehyde resins.

2.02 WOOD

A. Minimum lumber grade requirements for framing and sheathing:

Classification	Nominal Size	Species and Minimum Grade
Blocking and Bridging	2 by 3 through 2 by 14	Southern Pine Number 3
Miscellaneous	All sizes	Southern Pine Number 2

B. Species shall be as specified, or any combination of species allowed by grading rules.

C. Lumber 4 inches thick and less: Seasoned or kiln-dried with maximum 19 percent moisture.

D. Lumber thicker than 4 inches: Seasoned to minimize warping and twisting.

E. Lumber surfaces: Surfaced four sides (S4S), unless otherwise specified or indicated on the Drawings.

F. Lumber shall be free of bow, warp, or twist. Pieces with serious defects will be discarded regardless of grading.

2.03 PLYWOOD

A. Plywood:

1. DOC PS 1-07 for softwood plywood.

B. Plywood with edges or surfaces permanently exposed to weather: Exterior type with exterior type glue, Grade A-C.

C. Plywood roof sheathing: Exterior type with exterior type glue, of thickness and grade as indicated on the Drawings.

D. Plywood sheathing exposed at overhangs: Exterior type plywood with exterior type glue, Grade A-C or better.

E. Miscellaneous plywood: Exterior type plywood of thickness indicated on the Drawings, Grade A-C, or as otherwise indicated on the Drawings.

F. Plywood for roof diaphragms and shear walls: As indicated on the Drawings. When thicknesses given are not readily available, use the next thicker size available of the grade specified.

2.04 ROUGH HARDWARE

A. Fasteners:

1. Nails: ASTM F 1667 common wire nails or spikes with full head.

2. Bolts, nuts, and studs: ASME B18.2.1, hot-dip galvanized.

3. Washers: Hot-dip galvanized square or round steel plate washers, or malleable iron washers with following dimensions:

a. Hot-dip galvanized square steel washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 by 2-1/2 by 1/4 inches
5/8 inch	2-1/2 by 2-1/2 by 1/4 inches
3/4 inch	2-3/4 by 2-3/4 by 5/16 inches
7/8 inch	3-1/4 by 3-1/4 by 5/16 inches
1 inch	3-3/4 by 3-3/4 by 3/8 inches

b. Hot-dip galvanized round steel washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 inch diameter by 1/4 inch
5/8 inch	2-3/4 inch diameter by 1/4 inch
3/4 inch	3 inch diameter by 5/16 inch
7/8 inch	3-1/2 inch diameter by 3/8 inch

Bolt Diameter	Washer Dimensions
1 inch	4 inch diameter by 7/16 inch

c. Round malleable iron washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 inch diameter by 1/4 inch
5/8 inch	2-3/4 inch diameter by 5/16 inch
3/4 inch	3 inch diameter by 7/16 inch
7/8 inch	3-1/2 inch diameter by 7/16 inch
1 inch	4 inch diameter by 1/2 inch

4. Lag screws: ASME B18.2.1, hot-dip galvanized.

5. Wood screws: ASME B18.6.1.

6. Nails, screws, bolts, plates, and other fasteners exposed to weather or on building exteriors shall be hot-dip galvanized or of Series 300 stainless steel.

7. Anchor bolts, concrete anchors, flush shells, and powder actuated fasteners: As specified in Section 720S.

8. Sheet metal connectors:

   a. Manufacturers: One of the following or equal:

      1) Simpson Strong-Tie Company, Inc.

      2) USP Structural Connectors.

   b. Material: Sheet steel, hot-dip galvanized after fabrication. Material in contact with Pressure Treated Timber shall be stainless steel when available or extra heavy hot dip galvanized when stainless is not available.

   c. Model numbers: As indicated on the Drawings.

   d. Nails, typical: Common, hot-dip galvanized.

e. Nails, joist hanger: Special, hot-dip galvanized, providing full building code as specified in Section 01410 - Regulatory Requirements, lateral load resistance values for common nails.

f. Use manufacturer's recommended attachment hardware in all holes available. Hardware shall match the material of the connector.

B. Miscellaneous hardware:

1. Clamps, expansion screws, anchors, and plates: Standard products of established manufacturers of proper size and strength to adequately fasten, support, and maintain members in place.

2. Hardware exposed to weather or on building exteriors: Hot-dip galvanized.

C. Building paper: ASTM D 226; unperforated; No. 15 unless otherwise indicated.

2.05 FACTORY WOOD TREATMENT

A. Wood Preservative (Pressure Treatment): AWPA U1, Commodity Specifications A-Sawn Products or F-Wood Composites, using waterborne SBX preservative.

B. Wood Preservative (Surface Application):

1. Type: Borate based for wood pressure treated with SBX.

C. Fire-Retardant Treatment:

1. Chemically treated and pressure impregnated.

2. Flame Spread: 25 or less when tested according to ASTM E84 and showing no evidence of significant progressive combustion when test is continued for an additional 20 minutes.

3. Type: Interior.

D. Moisture Content after Treatment: Re-dried.

1. Lumber: Maximum 19 percent.

2. Structural Panels: Maximum 15 percent.

PART 3 - EXECUTION

3.01 APPLICATION

A. Sheathing:

1. Fasten sheathing according to applicable code.

B. Site-Applied Wood Treatment:

1. Brush-apply one coat of preservative treatment on cut ends and edges of preservative treated wood.

2. Treat Site-sawn cuts by applying preservative according to AWPA M4.

3. Allow preservative to dry prior to erecting members.

3.02 TOLERANCES

A. Section 01400 - Quality Control Services: Requirements for tolerances.

3.03 ATTACHMENTS

A. Blocking: Douglas fir; fire retardant treatment.

END OF SECTION 06100

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Vapor retarder, seam tape and mastic for installation under concrete slabs.

1.02 RELATED REQUIREMENTS

A. Section 403S – Concrete for Structures.

B. Section 02360 – Termite Control.

1.03 REFERENCE STANDARDS

A. ASTM International:

1. ASTM D1709 – Standard Test Methods for Impact Resistance of Plastic Film by Free-Falling Dart Method.

2. ASTM E96 - Standard Test Method for Water Vapor Transmission of Materials.

3. ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls or as Ground Cover.

4. ASTM E1643 – Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

5. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil and Granular Fill Under Concrete Slabs.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

1. Product Data: Submit data on vapor retarder, seam tape and mastic.

2. Manufacturer’s Instructions: Manufacturer’s installation instructions.

1.07 QUALITY ASSURANCE

A. Provide Manufacturer’s Samples, literature.

B. Provide Manufacturer’s installation instructions for placement, seaming and pipe boot installation

1.08 PRE-INSTALLATION MEETINGS.

A. Section 01200 – Project Meetings: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Protect materials during handling and application to prevent damage or contamination.

D. Ensure membrane is stamped with manufacturer’s name, product name, and membrane thickness at intervals of no more than 85” (220 cm).

1.10 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Do not apply to frozen ground.

1.11 NOT USED

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Shall conform to ASTM E1745, Class A.

B. Shall have a maximum water vapor permeance of 0.0095 perms when tested by ASTM E154 by ASTM E96.

C. Shall have a minimum puncture resistance of 2,250 grams when tested in accordance with ASTM D1709.

D. Shall have minimum thickness of 15 mils.

2.02 MANUFACTURERS AND MATERIALS

A. Stego Industries LLC., 887-464-7834

1. Stego Wrap – 15 mil.

B. Raven Industries, 605-336-2750;

1. VaporBlock -15 mil.

C. WR Meadows. 800-342-5976

1. Perminator – 15 mil.

2.03 ACCESSORIES

A. Seam tape: as recommended by vapor retarder manufacturer.

B. Sealing mastic: as recommended by vapor retarder manufacturer.

C. Mastic: as recommended by manufacturer.

D. Pipe Boots: as recommended by manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that substrate conditions are acceptable for product installation in accordance with manufacturer's instructions.

B. Level, tamp, or roll earth or granular material beneath the slab base.

3.02 INSTALLATION

A. Install vapor retarder in accordance with manufacturer's instructions and ASTM E1643.

B. Lay sheet smoothly, stretch and weight edges, lap joints a minimum of 6 inches and seal with tape as specified by vapor retarder manufacturer.

C. Turn retarder up 6 inches at walls and at all pipes, abutments, etc. Tape and seal at penetrations and edges.

D. At grade beams, lay vapor retarder down sides and bottom of grade beam and extend beyond a minimum of 12 inches beyond the grade beam under the slab. Over lap vapor retarder for slab a minimum of 6" over the grade beam vapor retarder and seal with tape as specified by vapor retarder manufacturer.

E. At piers and footings, extend vapor retarder to overlap edge and seal to concrete with mastic or tape or other method recommended by vapor retarder manufacturer.

3.03 PROTECTION

A. Section 01700 - Contract Closeout: Requirements for protecting finished Work.

B. Protect membrane during and post installation from penetrations. Do not drive temporary stakes through membrane.

3.04 PATCHING

A. Patch and repair all punctures with a minimum overlap of 6 inches in all directions and tape around entire perimeter of repair.

3.05 SCHEDULE

A. Below slab at the Blower Building

END OF SECTION 07160

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Insulation and liner system for new Pre-Engineered Building Construction.

1.02 RELATED REQUIREMENTS

A. Section 07213 – Batt Insulation: Adjacent components of the insulating envelope.

B. Section 07415 – Metal Roofing: Roofing panels and clips integrated with the roof insulation of this section.

C. Section 07468 – Metal Siding: Exterior and interior metal panels between wall insulation of this section.

D. Section 09260 – Gypsum Board Assemblies: Interior wall panels covering wall insulation of this section.

E. Section 13120 – Metal Building Systems: Beams, Purlins, Girts, and other framing members to which insulation of this section are secured.

F. Division 15 – Fire Protection.

G. Division 15 – Plumbing

H. Division 15 – Mechanical

I. Division 16 – Electrical

J. Division 16 – Communications

K. Division 16 – Electronic Safety and Security

1.03 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

2. ASTM C991 - Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings

3. ASTM C 1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

4. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

5. ASTM E96 - Standard Test Method for Water Vapor Transmission of Materials in Sheet Form (Procedure B).

B. National Fire Protection Association

1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratory

1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittal Procedures: Requirements for submittals.

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 instructions.

C. Shop Drawings:

1. Indicate locations of connections and attachments, general details, anchorages and method of anchorage and installation.

D. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify that the following products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

3. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

a. Provide cost data for the following products:

1) Products with recycled material content.

2) Regional products

1.07 PREINSTALLATION MEETINGS

A. Section 01200 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing product systems specified in this section with minimum five years documented experience.

B. Installer Qualifications: Company specializing in performing work of this section.

C. Insulation system components to include a ten-year limited material warranty.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Remove insulation that becomes wet or damp.

3. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Maintain environmental conditions (temperature, humidity, and ventilation) within recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.11 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

A. Upon successful completion of the project, and after all post installation procedures have been completed, furnish the Owner with the manufacturer's ten year material warranty.

PART 2 - PRODUCTS

2.01 SUSTAINABLE CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

1. Materials and Resources Characteristics:

a. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.02 MANUFACTURERS

A. Batt Insulation: the following or approved equal:

1. Acceptable Manufacturer: Thermal Design, Inc., Simple Saver System. P.O. Box 468, 601 N. Main Street, Madison, NE 68748. ASD. Tel: (800) 255-0776 or (402) 454-6591. Fax: (402) 454-2708. Email: sales@thermaldesign.com, www.thermaldesign.com

B. Substitutions: As specified in Section 01200 – Substitution Procedures.

2.03 MATERIALS

A. Simple Saver System consists of Batt Insulation, Roof Insulation, Wall Insulation, Vapor Barrier Liner Fabric, Thermal Breaks, Straps, and other devices and components in a proprietary insulation system as follows:

1. Roof Insulation: Formaldehyde-free fiberglass batt or fiberglass blanket complying with ASTM C 991 Type 1 and ASTM E 84 with a thermal resistance and thickness as follows:

a. Batt Size: Equal to purlin/girt spacing by manufacturer’s standard lengths.

b. Unfaced.

c. R-29; 9 inches (229 mm), 6 inches (152 mm) plus 3 inches (76 mm) (two layers).

2. Wall Insulation: Formaldehyde-free fiberglass blanket or batt complying with ASTM C 991 Type 1, ASTM E 136 and ASTM E 84 with a thermal resistance and thickness as follows:

a. Batt Size: Equal to purlin/girt spacing by manufacturer's standard lengths.

b. Unfaced.

c. R-25; 8 inches (203 mm).

3. Vapor Barrier Liner Fabric: Syseal® type woven, reinforced, high-density polyethylene yarns coated on both sides with a continuous white or colored polyethylene coatings, as follows:

a. Product complies with ASTM C 1136, Types I through Type VI.

b. Perm rating: 0.02 for fabric and for seams in accordance with ASTM E96.

c. Flame/Smoke Properties:

1) 25/50 in accordance with ASTM E 84.

2) Self-extinguishes with field test using matches or butane lighter.

d. Ultra violet radiation inhibitor to minimum UVMAX® rating of 8.

e. Size and seaming: Manufactured in large custom pieces by extrusion welding from roll goods, and fabricated to substantially fit defined building area with minimum practicable job site sealing.

f. Provide with factory double, extrusion welded seams. Stapled seams or heat-melted seams are not acceptable due to degradation of fabric.

g. Factory-folded to allow for rapid installation.

h. Color: Custom color as selected by Architect.

4. Vapor Barrier Lap Sealant: Solvent-based, Simple Saver polyethylene fabric adhesive.

5. Vapor Barrier Tape: Double-sided sealant tape 3/4 inch (19 mm) wide by 1/32 inch (.79 mm) thick.

6. Vapor Barrier Patch Tape: Single-sided, adhesive backed sealant tape 3 inches (76 mm) wide made from same material as Syseal® type liner fabric.

7. Thermal Breaks:

   a. 1/8 inch (3 mm) thick by 3 inch (76 mm) wide white, closed-cell polyethylene foam with pre-applied adhesive film and peel-off backing.

   b. Polystyrene Snap-R snap-on thermal blocks.

8. Straps:

   a. 100 KSI minimum yield tempered, high-tensile-strength steel.

   b. Size: Not less than 0.020 inch (0.50 mm) thick by 1 inch (25 mm) by continuous length.

   c. Galvanized, primed, and painted to match specified finish color on the exposed side.

      1) Color: as selected by Architect.

9. Fasteners:

   a. For light gage steel: #12 by 3/4 (19 mm) inch plated Tek 2 type screws with sealing washer, painted to match specified color.

   b. For heavy gage steel: #12 by 1-1/2 inch (38 mm) plated Tek 4 type screws with sealing washer, painted to match specified color.

   c. For wood, concrete, other materials: As recommended by manufacturer.

10. Wall Insulation Hangers: Fast-R preformed rigid hangers, 32 inch (813 mm) long galvanized steel strips with barbed arrows every 8 inches (203 mm) along its length.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field conditions are acceptable and are ready to receive Work.

C. Verify that building structure including all bracing and any concealed building systems are completed and approved prior to installing liner system and insulation in the structure.

D. Correct any unsatisfactory conditions before proceeding.

3.02 INSTALLATION - GENERAL

A. Install pre-engineered building insulation system in accordance with manufacturer's installation instructions and the approved shop drawings.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Install in exterior spaces without gaps or voids. Do not compress insulation.

D. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

E. Fit insulation tight in spaces and tight to exterior side of the sealed liner fabric and around mechanical and electrical services within plane of insulation.

3.03 INSTALLATION – ROOF INSULATION

A. Straps:

1. Cut straps to length and install in the pattern and spacings indicated on shop drawings.

2. Tension straps to required value.

B. Vapor Barrier Fabric:

1. Install vapor barrier fabric in large one-piece custom fabricated pieces to substantially fit defined building areas with minimum practicable job site sealing.

2. Position pre-folded fabric on the strap platform along one eave purlin.

3. Clamp the two bottom corners at the eave and also centered on the bay.

4. Pull the other end of the pleat-folded fabric across the building width on the strap platform, pausing only at the ridge to fasten the straps and

fabric in position where plane of roof changes and to release temporary fasteners on the opposite ridge purlins.

5. Once positioned, install fasteners from the bottom side at each strap/purlins intersection.

6. Trim edges and seal along the rafters.

7. All seams must be completely sealed and stapled seams not acceptable.

C. Insulation:

1. Unpack, and shake to a thickness exceeding the specified thickness.

2. Ensure that cavities are filled completely with insulation.

3. Place on the vapor barrier liner fabric without voids or gaps.

4. Place top layer of insulation over and perpendicular to the purlins without voids or gaps, as roof sheathing is applied.

5. Place thermal block on top of purlins or bottom of purlins for retrofit work, if no other thermal break exists.

6. Place new insulation between purlins at the required thickness for the R-value specified.

D. Seal vapor barrier fabric to the wall fabric and elsewhere as required to provide a continuous vapor barrier.

3.04 INSTALLATION – WALL INSULATION

A. Insulation:

1. Install thermal break to exterior surface of girts as wall sheathing is applied.

2. Install self-sticking foam thermal break to interior surface of girts prior to installation of insulation.

3. Position and secure Fast-R hangers to girts on the inside face of the wall sheathing.

4. Cut insulation to required lengths to fit vertically between girts.

5. Fluff the insulation to the full-specified thickness.

6. Neatly position in place and secure to Fast-R hangers.

7. Ensure that cavities are filled completely with insulation.

B. Vapor Barrier Fabric:

1. Install vapor barrier fabric in large one-piece custom fabricated pieces to substantially fit defined building areas with minimum practicable job site sealing.

2. Apply the vapor barrier fabric by clamping it in position over eave strap and installing fasteners through the eave strap into each roof strap, permanently clamping the wall fabric between them.

3. Once in position, draw the vapor barrier fabric down over the column flanges to the base angle and install vertical straps along each column and 5 feet 0 inches on center, maximum, fastening to each girt to retain system permanently in place.

4. All seams must be completely sealed and stapled seams not acceptable.

C. Seal wall fabric to the roof fabric, to the base angle and up the columns to provide a continuous vapor barrier.

3.05 CLEANING

A. Section 01700 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean dirt or exposed sealant from the exposed vapor barrier fabric.

C. Remove scraps and debris from the site.

3.06 PROTECTION

A. Section 01700 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect system products until completion of installation.

C. Repair or replace damaged products before completion of insulation system

3.07 SCHEDULE

A. Blower Building:

1. Roof insulation general: R-29.

2. Exterior Wall insulation general: R-25.

END OF SECTION 07210

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior walls and roofs.

2. Section includes batt insulation in interior wall and ceiling construction for thermal and acoustical control.

1.02 RELATED REQUIRMENTS

A. Section 06100 – Rough Carpentry.

B. Section 08110 – Steel Doors and Frames.

C. Section 08410 – Metal Framed Storefronts.

D. Section 09260 - Gypsum Board Assemblies: Assemblies for addition of acoustic insulation.

E. Section 09511 - Acoustical Ceiling Panels: Assemblies for addition of acoustic insulation.

1.03 REFERENCE STANDARDS

A. ASTM International:

B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. ASTM E970 - Standard Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source.

1.04 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit manufacturer data on product characteristics, performance criteria, and limitations.

C. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

D. SUSTAINABLE DESIGN SUBMITTALS

E. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

F. Manufacturer's Certificate: Certify that following products meet or exceed specified sustainable design requirements.

1. Materials Resources Certificates:

a. Certify recycled material content for recycled content products.

2. Indoor Air Quality Certificates:

a. Certify VOC content for each interior adhesive and sealant and related primer.

1.05 COORDINATION

A. Section 01310 – Schedules and Reports: Requirements for coordination.

B. Coordinate Work of this Section with Section 07160 - Sheet Vapor Retarders for installation of vapor retarder and Section 07270 - Air Barriers for air seal materials.

C. Provide continuity of thermal barrier at building enclosure elements in conjunction with thermal insulating materials in Section 13122 – Metal Building Systems.

D. Coordinate the Work with Section 06100 for installation of framing and blocking, Section 09260 for installation of framing and gypsum panels, and Section 09511 for installation of suspended acoustical ceilings, and Section 13122 for installation of framing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Remove insulation that becomes wet or damp.

3. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Thermal Protection of Air Seal Materials at Building Enclosure Elements: In conjunction with air barrier materials as specified in Section 07270 - Air Barriers.

B. Materials of This Section: Provide acoustical attenuation within interior partitions and between specified rooms.

2.02 THERMAL BATT INSULATION

A. Manufacturers: Fiberglass unfaced thermal batt insulation

1. CertainTeed Insulation: CertaPro AcoustaTherm Batts.

2. Johns Manville: Unfaced Insulation.

3. Knauf Fiber Glass: EcoBatt.

4. Owens Corning Fiberglas: EcoTouch Pink Fiberglas

5. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

B. Manufacturers: Mineral wool thermal batt insulation

1. Johns Manville: TempControl Mineral Wool.

2. Owens Corning: Thermafiber UltraBatt

3. Rock Wool Manufacturing Company: Comfortbatt.

4. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.03 ACOUTICAL BATT INSULATION

A. Manufacturers: Fiberglass unfaced acoustic batt insulation

1. CertainTeed Insulation: CertaPro AcoustaTherm Batts.

2. Johns Manville: Unfaced Insulation.

3. Knauf Fiber Glass: EcoBatt.

4. Owens Corning Fiberglas: EcoTouch Sound Attenuation Batts Insulation.

5. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

B. Manufacturers: Mineral wool acoustical batt insulation

1. Johns Manville: MinWool Sound Attenuation Fire Batts.

2. Owens Corning: Thermafiber SAFB.

3. Rock Wool Manufacturing Company: AFB.

4. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.04 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2. Indoor Environmental Quality Characteristics:

a. Interior Adhesives: Maximum VOC content according to SCAQMD Rule 1168.

b. Interior Aerosol Adhesives: Maximum VOC content according to GS-36.

2.05 MATERIALS

A. Batt Insulation:

1. Description: Preformed glass or mineral-fiber batt, with friction fit.

2. Comply with ASTM C665, Type I.

3. Thermal Resistance:

a. Minimum R-value of 13 h-sq. ft.-degree F/Btu for walls framed with 3-5/8" metal framing.

b. Minimum R-value of 19 h-sq. ft.-degree F/Btu for walls framed with 6" metal framing.

4. Size:

a. 24X48 inch batts at installations above suspended acoustical ceilings.

b. Batt Size: 16 inches wide, sized to fit wall framing. length in manufacturer's standard lengths as appropriate for conditions of the project.

5. Facing: Unfaced.

6. No added Urea-formaldehyde.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for application examination.

B. Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.

3.02 INSTALLATION

A. Install in wall and ceiling spaces without gaps or voids.

B. Do not compress insulation.

C. Trim insulation neatly to fit spaces.

D. Insulate miscellaneous gaps and voids.

E. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within plane of insulation.

3.03 ATTACHMENTS

A. Contractor may provide/install either fiberglass or mineral wool batt insulation at Contractor's option. All insulation shall be of the same type and manufacturer.

B. Interior Metal Framed Walls scheduled for sound attenuation batts:

1. 3-1/2" to 3-5/8" unfaced sound attenuation batts in walls framed with 3-5/8" metal studs.

    a. Partition between Rooms 05-101 Sample Station and 05-102 Electrical.

C. Interior Metal Framed Walls scheduled for thermal batts:

1. 3-1/2" to 3-5/8" unfaced thermal batts, minimum R-13, in walls framed with 3-5/8" metal studs.

    a. Partitions between:

        1) 05-101 Sample Station and 05-100 Blower Room.

        2) 05-102 Electrical and 05-103 Mechanical.

    b. 6-1/4" to 6-1/2" unfaced thermal batts, minimum R-19, in walls framed with 6" metal studs.

        1) Partition between 05-101 Sample Station and 05-103 Mechanical.

D. Interior suspended acoustical tile ceilings scheduled for sound attenuation batts:

1. 3-1/2” to 3-5/8” unfaced thermal batts.

2. Above ceiling at 05-101 Sample Station.

END OF SECTION 07213

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air leakage criteria for primary air seal between conditioned and unconditioned spaces within the building, including materials and assemblies;

2. Materials and installation methods supplementing other air seal materials and assemblies; and air seal materials to connect and seal openings, joints, and junctions between other air seal materials and assemblies.

1.02 RELATED REQUIREMENTS:

A. Section 07468 – Metal Siding.

B. Section 07900 - Joint Sealers: Sealant materials and installation techniques.

C. Section 08110- Steel Doors and Frames

D. Section 09260 - Gypsum Board Assemblies.

E. Section 09 27 13 - Glass-Fiber-Reinforced Plaster Fabrications.

F. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior walls and roofs.

1.03 REFERENCES

A. American Society of Civil Engineers:

1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

B. ASTM International:

1. ASTM D1117 - Standard Guide for Evaluating Nonwoven Fabrics

2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials .

3. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials

4. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

5. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.

6. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies.

C. AATCC – American Association of Textile Chemists and Colorists

1. Test Method 127 Water Resistance: Hydrostatic Pressure Test

D. TAPPI

1. T-460 – Air Resistance of Paper (Gurley Hill Method).

E. Sealant, Waterproofing and Restoration Institute:

1. SWRI - Sealant Specification.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data on material characteristics, performance criteria, limitations.

C. Manufacturer's Installation Instructions: Submit preparation, installation requirements and techniques, product storage and handling criteria.

D. Sustainable Design Submittals

1. Section 01352- Sustainable Design Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

    a. Materials Resources Certificates:

        1) Certify recycled material content for recycled content products.

3. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

    a. Provide cost data for the following products:

1.07 COORDINATION

A. Coordinate the Work of this section with sections referencing this section.

1.08 SEQUENCING

A. Section 01010 – Summary of Work: Work sequence.

B. Sequence Work to permit installation of materials in conjunction with related materials and seals.

1.09 QUALITY ASSURANCE

A. Perform Work in accordance with SWRI - Sealant and Caulking Guide Specification requirements for materials and installation.

1.10 AMBIENT CONDITIONS

A. Section 01600 - Product Requirements.

B. Maintain temperature and humidity recommended by materials manufacturers before, during and after installation.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. Perform design work in accordance with ASCE 7.

B. Provide continuity of air seal materials and assemblies in conjunction with materials described in Section 03 30 00, 07213, 07 90 00, 08110 and 09260.

C. Static Test: Resist air leakage caused by static air pressure across exterior wall assemblies and other interruptions to integrity of building enclosure systems; to maximum air leakage rate of 0.01 cfm/sq ft when subjected to pressure differential of 1.57 lb/sq ft when tested in accordance with ASTM E283.

D. Dynamic Test: Resist air leakage caused by dynamic air pressure across exterior wall assemblies and other interruptions to integrity of wall and roof systems; to maximum air leakage rate of 0.01 cfm/sq ft when subjected to pressure differential of 1.57 lb/sq ft when tested in accordance with ASTM E283.

E. Vapor Permeance: Resist vapor transmission to between 10 and 30 perms for building wrap and 50 perms maximum for drainable wrap, when tested in accordance with ASTM E96.

F. Water Penetration Resistance: minimum280 for building wrap cm when tested in accordance with AATCC Test Method 127.

G. Air Resistance: Air infiltration at >1500 seconds for building wrap and 750 seconds for drainable wrap, when tested in accordance with TAPPI Test Method T-460.

H. Air Resistance: Air penetration resistance less than 0.01 for building wrap cfm/sf at 1.57 psf when tested in accordance with ASTM E2357.

I. Tear Resistance: Minimum 12/10 for building wrap lbs., when tested in accordance with ASTM D1117.

J. Surface Burning Characteristics: When tested in accordance with ASTM E84:

1. Flame Spread: Class A

2. Smoke Developed: 25

2.02 AIR BARRIERS

A. Manufacturers:

1. Dupont Tyvek; Commercial Wrap.

2. Typar; MetroWrap.

3. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.03 SUSTAINABILITY CHARACTERISTICS

A. Section 01352- Sustainable Design Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.04 COMPONENTS

A. Building Wrap : Non-woven spunbound Polyolefin fiber in sheet membrane, minimum 11 mil thick.

2.05 ACCESSORIES

A. Tape: Polyolefinself adhering type, 2 inch nominal minimum wide, compatible with sheet material and as recommended by manufacturer.

B. Flashings: Polyolefin self adhering type, 2 inch nominal minimum wide, compatible with sheet material and as recommended by manufacturer. Straight and flexible flashings.

C. Fasteners: Per manufacturer’s recommendations.

D. Sealants: Per Section 07 90 00 and as compatible with air barrier manufacturer’s recommendation.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean and prime substrate surfaces to receive adhesive and sealants per manufacturer’s recommendation.

B. Protect adjacent surfaces not designated to receive waterproofing.

C. Clean and prepare surfaces to receive waterproofing.

D. Do not apply weather barrier to surfaces unacceptable to manufacturer.

E. Seal cracks and joints with sealant materials using depth to width ratio in accordance with Section 07900.

3.02 INSTALLATION

A. Roll out membrane. Minimize wrinkles.

B. Install mechanical fasteners in accordance with manufacturer's installation process instructions.

C. Overlap edges and ends.

D. Weather lap joints on sloped substrate in direction of drainage.

E. Seal items protruding to or penetrating through membrane and install counterflashing membrane material.

F. Installation – Self Sealant Flashing Around Windows

G. Flashing is first applied at the sill and then jambs of window openings.

H. Overlap edges minimum of 3 inches on each side.

3.03 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01700 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit adjacent work to damage work of this section.

3.04 SCHEDULES

A. Interior walls separating conditioned spaces from unconditioned spaces.

B. Reference Partition Types in the Drawings for more information.

END OF SECTION 07270

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Structural standing seam metal roofing.

2. Structural supports.

3. Eave protection.

1.02 RELATED REQUIREMENTS

A. Section 06100 - Rough Carpentry.

B. Section 07210 – Pre-Engineered Building Insulation: Flexible insulation under sheet metal roofing system.

C. Section 07600 – Flashing and Sheet Metal: Sheet metal, flashing, and trim associated with roofing and waterproofing membranes.

D. Section 07714 - Gutters and Downspouts: Shop- or Site-fabricated metal rainwater gutters and downspouts.

E. Section 07900 - Joint Sealers: Sealants, sealers, and gaskets for sealing static and dynamic joints and joints between differing materials and components.

F. Section 13120 – Metal Building Systems: Pre-engineered metal building.

1.03 REFERENCE STANDARDS

A. American Architectural Manufacturers Association:

1. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. American Iron and Steel Institute:

1. AISI NASPEC - North American Specification for the Design of Cold-Formed Steel Structural Members.

C. American Society of Civil Engineers:

1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

D. ASTM International:

1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

2. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.

3. ASTM A792 – Standard Specification for Steel Sheet, 55% Aluminum Zinc Alloy Coated by the Hot Dip Process.

4. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

5. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.

6. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.

7. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

8. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.

9. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free.

10. ASTM E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

11. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

12. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.

13. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.

14. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.

15. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

16. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.

17. ASTM E1680 - Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems.

E. Federal Specification Unit:

1. FS TT-C-494 - Coating Compound, Bituminous, Solvent Type, Acid Resistant.

F. National Roofing Contractors Association:

1. NRCA - Roofing and Waterproofing Manual.

G. Sheet Metal and Air Conditioning Contractors' National Association:

1. SMACNA - Architectural Sheet Metal Manual.

H. UL:

1. UL 580 - Tests for Uplift Resistance of Roof Assemblies.

I. U.S. Environmental Protection Agency:

1. ENERGY STAR - ENERGY STAR Voluntary Labeling Program.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data:

1. Submit fabricator information on metal types, finishes, and characteristics.

2. Submit color charts for finish selection.

C. Shop Drawings:

1. Indicate metal roofing panel profiles, jointing patterns, jointing details, fastening methods, flashings, terminations, and installation details.

D. Samples:

1. Submit samples, 8 by 8 inch in size, illustrating metal finish color.

E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for metal roofing.

F. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Fabricator's Certificate: Certify that products meet or exceed specified sustainable design requirements.

a. Sustainable Sites Certificates: Certify roofing materials' solar reflectance index (SRI).

b. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

1.07 COORDINATION

A. Section 01310 – Schedules and Reports: Requirements for coordination.

B. Coordinate Work of this Section with Work of Section 13122 – Pre-Engineered Building Insulation for insulation installed within roof assembly Metal Building Systems for connecting structural supports to building structural frame.

1.08 PREINSTALLATION MEETINGS

A. Section 01200 – Project Meetings: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

C. Meeting to be held in conjunction with preinstallation meetings for Sections 07600, and 07714.

D. Required attendees: Owner, Architect, General Contractor, and sub-contractors installing roofing, sheet metal trim, gutters.

1.09 QUALITY ASSURANCE

A. Calculate structural properties of framing members according to AISI NASPEC.

B. Perform Work according to SMACNA Architectural Sheet Metal Manual and NRCA Roofing and Waterproofing Manual.

1.10 QUALIFICATIONS

A. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years’ experience.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Texas.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:

1. Store materials according to fabricator instructions.

2. Stack material to provide ventilation and to prevent twisting, bending, and abrasion.

3. Slope metal sheets to ensure drainage.

D. Protection:

1. Prevent contact with materials causing discoloration or staining.

2. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

3. Provide additional protection according to fabricator instructions.

1.12 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

1.13 WARRANTY

A. Section 01700 - Contract Closeout: Requirements for warranties.

B. Installer’s Warranty: Warrant all materials and installation of roof system for two (2) years against leaks and defects in materials and workmanship.

C. Manufacturer’s Warranties:

1. Provide standard 20-year water-tightness warranty

2. Provide pre-finished metal with a standard twenty (20) year finish warranty.

D. Warranties shall commence on the data of Substantial Completion for the overall project.

PART 2 - PRODUCTS

2.01 MANUFACTURED SHEET METAL ROOFING

A. Manufacturers:

1. Berridge Manufacturing Company, Houston, TX; Double Lock Zee-Lock as basis of design.

2. AEP Span, Dallas, Texas; Span Seam.

3. Atas International, Inc., Allentown, PA; Field Lock 2".

4. Dimensional Metals Inc. (DMI), Reynoldsburg, OH; DL20.

5. Fabral, Idabel, OK; Powerseam.

6. Holcim Elevate; UC-6.

7. MBCI Systems, Houston, TX; SuperLok Panel.

8. Petersen Aluminum, Tyler, TX; Tite-Loc Plus.

9. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.02 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Sustainable Sites Characteristics:

1. Roof Surfaces:

a. Comply with ENERGY STAR.

b. Minimum Emissivity: 0.9 for 75 percent of roof area, according to ASTM E408.

C. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.03 MATERIALS

A. Sheet Metal:

1. Prefinished Galvalume Steel Sheet:

a. Description: Coil coated.

b. Comply with ASTM A755/A755M.

c. Base Metal:

1) Comply with ASTM A792/A792M.

2) Quality: Structural.

3) Grade: 50.

4) Coating: Aluminum-zinc alloy; Class AZ50.

5) Thickness: 22 ga.

d. Exposed Finish Coating: Minimum three coats fluoropolymer with minimum 70 percent PVDF resin.

1) Comply with AAMA 2605.

e. Unexposed Finish Coating: Fabricator's standard.

2.04 FABRICATION

A. Form section shapes as indicated in the manufacturer’s product data sheets and on Drawings, accurate in size, square, and free from distortion or defects.

B. Seams:

1. Form material with standing seams, except where otherwise indicated.

a. Bend seam to180 degrees.

2. Fabricate cleats of same material as sheet, to interlock with sheet.

a. At moving joints, use sealed lapped, Cleats:

b. Material: Same as sheet.

c. Interlock with sheet.

C. Starter Strips:

1. Description: Continuous, to interlock with sheet.

2. Material: Same as sheet.

D. Form pieces in single-length sheets.

E. Hems and Seams:

1. Hem exposed edges on underside 1/2 inch.

2. At moving joints, use sealed and lapped bayonet-type or interlocking hooked seams.

F. Corners:

1. One piece.

2. Minimum Leg Length: 18 inches.

3. Miter and seam corners and seal with sealant.

2.05 ACCESSORIES

A. Fasteners:

1. Material: Stainless steel.

2. Washers: Soft neoprene washers.

B. Sealant: Type recommended by roofing panel manufacturer.

C. Plastic Cement: Comply with ASTM D4586/D4586M, Type I.

D. Vent Pipe Flashing Collars: EPDM collar with flexible aluminum base, Dektite Original or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for installation examination.

B. Deck Substrate:

1. Inspect roof deck to verify that deck is clean and smooth; free of depressions, waves, or projections; and properly sloped to eaves.

2. Verify that deck is dry.

3. Verify that wood nailers are installed and correctly located.

C. Verify that roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, reglets are in place, and nailing strips are located properly.

D. Verify that roofing termination and base flashings are in place, sealed, and secure.

E. Verify that insulation is installed and ready for roof application.

3.02 PREPARATION

A. Section 01700 - Contract Closeout: Requirements for installation preparation.

B. Install starter and edge strips, and cleats before starting installation. Coordinate with work of Sections 07600 and 07714.

C. Back paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to minimum dry film thickness of 15 mils.

3.03 INSTALLATION

A. General Roofing Installation Requirements:

1. Install roofing panels in accordance with manufacturer’s specific installation instructions and in conformance with SMACNA Architectural Sheet Metal Manual and NRCA Roofing and Waterproofing Manual, and as described below, in order to achieve a watertight installation.

2. Cleat and seam joints.

3. Install sealants for preformed roofing panels as directed by the manufacturer.

4. Provide formed metal pans for protrusions through roof. Fill pans watertight with plastic cement.

5. Protect installed roof panels and trim from damage caused by adjacent construction until completion of installation.

6. At eaves ends, terminate roofing by hooking over edge strip.

7. Install fascia trim and gutters at applicable roofs in accordance with sections 07620 and 07714 for a complete system application.

8. Do not allow panels or trim to come into contact with dissimilar materials. Back paint surfaces in contact with dissimilar materials with bituminous coating.

9. Remove and replace any panels or components which are damaged beyond repair.

B. Structural Supports:

1. As indicated on Shop Drawings.

2. Align supports with top surface in plane, uniformly sloped to eaves.

3. Spacing:

a. Maximum 3 feet o.c.

b. Provide support at roof panel end laps.

4. Secure supports to building structural frame with mechanical fasteners; welding is not permitted.

C. Underlayment:

1. Underlayment is integral to the building insulation system. Install per Section 07210.

D. Standing Seam Roofing Installation:

1. Space standing seams at 16 inch oc.

2. Eaves:

    a. Lay sheets with long dimension perpendicular to eaves.

    b. Apply pans beginning at eaves. Install panels in such a manner that horizontal lines are true and level and vertical lines are plumb and perpendicular to horizontal elements.

3. Install fasteners through anchor clips to penetrate through insulation spacer clips and into metal purlins. Use plastic cement for joints between metal and bitumen and for joints between metal and sheet underlayment.

4. Provide panels in full length from ridge to eave when possible. When not full length from ridge to eave is not feasible or outside of manufacturer’s length limit/recommendation, Align transverse joints of roofing sheets .

5. Attach panels using manufacturer's job specific anchor clips and fasteners, spaced in accordance with manufacturer's instructions and code requirements to meet UL 90 assembly uplift requirements but no less than one anchor clip for each two square feet of roof area (16" O.C.).

6. At eaves and gable ends, terminate roofing by hooking over edge strip.

7. Finish standing seams at manufacturer’s specified height. Bend and fold in accordance with manufacturer’s instructions.

8. Fold lower ends of seams at eaves over at 45 degree angle.

9. Terminate standing seams at ridge and hips by turning down with tapered fold.

E. Flashing:

    a. As specified in Section 07600 Flashing and Sheet Metal.

3.04 PROTECTION

A. Section 01700 - Contract Closeout: Requirements for protecting finished Work.

B. Do not permit traffic over unprotected roof surface.

END OF SECTION 07415

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes preformed metal siding system for walls, and soffits, with related flashings and accessory components.

1.02 RELATED REQUIREMENTS

A. Section 06100 - Rough Carpentry: Framing: Wood Blocking.

B. Section 07210 – Pre-Engineered Building Insulation.

C. Section 07213 - Batt Insulation.

D. Section 07415 – Metal Roofing.

E. Section 07600 – Flashing and Sheet Metal including metal cap flashing over metal siding.

F. Section 07714 – Gutters and Downspouts

G. Section 08110 – Steel Doors and Frames.

H. Section 08330 – Architectural Overhead Coiling Doors.

I. Section 08410 – Metal Framed Storefronts.

J. Section 09260 – Gypsum Board Assemblies.

K. Section 13120 - Metal Building Systems: Building framing system.

1.03 REFERENCES

A. American Society of Civil Engineers:

1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

B. ASTM International:

1. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

2. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.

3. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

4. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

5. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

6. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

8. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

9. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Submittal procedures.

B. Shop Drawings: Indicate dimensions, layout, joints, expansion joints, construction details, methods of anchorage, and interface with adjacent materials.

C. Product Data: Submit data on panels.

D. Submit manufacturer’s color selector for panel finish.

E. Manufacturer's Installation Instructions: Submit special procedures.

F. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

    a. Materials Resources Certificates:

        1) Certify recycled material content for recycled content products.

1.07 QUALITY ASSURANCE

A. Surface Burning Characteristics:

1. Insulation: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

B. Apply label from agency approved by authority having jurisdiction to identify each foam plastic insulation material.

1.08 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Product storage and handling requirements.

B. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.

C. Store prefinished material off ground protected from weather, to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

D. Prevent contact with materials capable of causing discoloration or staining.

1.10 COORDINATION

A. Section 01310 – Schedules and Reports: Coordination and project conditions.

B. Coordinate Work for installation of vapor retarder and air barrier seals.

C. Coordinate Work with installation of windows, louvers, and doors adjacent components or materials.

1.11 WARRANTY

A. Section 01700 - Contract Closeout: Product warranties and product bonds.

B. Furnish ten year manufacturer warranty for metal siding material and workmanship.

C. Furnish ten year manufacturer weather tightness warranty.

D. Furnish thirty year manufacturer warranty for metal siding finish.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. System: Preformed and prefinished metal siding system of vertical profile; site assembled.

2.02 EXTERIOR METAL WALL PANELS – EXPOSED FASTENER

A. Manufacturers:

1. Berridge Manufacturing Company: R Panel as basis of design.

2. MBCI: PBR Panel.

3. AEP Span; A BlueScope Steel Company: PBR Panel.

4. ATAS International: BWG390.

5. Englert inc.; Uniline R Wall Panel.

6. Fabral: Mighti-Rib.

7. McElroy Metal, Inc. R-Panel.

8. Metal Sales Manufacturing Corporation. PBR-Panel.

9. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company. R-36 Panels.

10. Union Corrugating Company. PBR Panel.

11. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.03 INTERIOR METAL WALL PANELS – EXPOSED FASTENER - SOLID

A. Manufacturers:

1. Berridge Manufacturing Company: Deep-Deck Panel as basis of design.

2. MBCI: 7.2 Panel.

3. AEP Span; A BlueScope Steel Company: Nu-Wave Corrugated.

4. ATAS International, Inc.: BWR360.

5. Englert, Inc. Uniline C-36.

6. Fabral: Hefti-Rib.

7. McElroy Metal, Inc. Mega-Rib.

8. Metal Sales Manufacturing Corporation. IC72-Panel.

9. Metl Span. 7.2 Style Rib.

10. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company. 7.2 Panel.

11. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.04 EXTERIOR METAL SOFFIT AND FASCIA PANELS – CONCEALED FASTENER

1. Berridge Manufacturing Company: FW-12 with 2 grooves as basis of design.

2. AEP Span; A BlueScope Steel Company: Prestige Panel with wave with 2 pencil rib.

3. ATAS International, Inc.: DSF120.

4. Fabral: Select Series 12.

5. Flexospan Steel Buildings, Inc.: FE-12- two ribs.

6. MBCI: FW-120.

7. McElroy Metal, Inc.; FW Vee Grooves Profile.

8. Metal Sales Manufacturing Corporation.: TL-17 Soffit Panel.

9. Metl Span: FW-120.

10. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company:Flush Wall Panel- 2 pencil ribs.

11. Union Corrugating Company: FL100 with 2 pencil ribs.

12. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2.05 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.06 COMPONENTS

A. Exterior Panels and Other Sheet Materials: Minimum 22 gage thick precoated steel stock; R Panel profile by Berridge as basis of design; 36 inches wide panel; lapped edges, per manufacturer’s recommendation.

1. Precoated Aluminum-Zinc Alloy Coated Steel: ASTM A755/A755M; AZ 50aluminum-zinc alloy coating; shop precoated with polyvinyl fluoride (PVF) coating. Exposed Exterior Surfaces: Color from manufacturer's standard range.

B. Interior Panels and Other Sheet Materials: Minimum 22 gage thick precoated steel stock; Deep-Deck Panel profile by Berridge as basis of design; 36 inches wide panel; lapped edges, per manufacturer’s recommendation.

1. Precoated Aluminum-Zinc Alloy Coated Steel: ASTM A755/A755M; AZ 50aluminum-zinc alloy coating; shop precoated with polyvinyl fluoride

(PVF) coating. Exposed Exterior Surfaces: Color from manufacturer's standard range.

C. Soffit Panels: 22 gage thick pre-coated steel, FW-12 profile by Berridge as basis of design, in 12 inch wide panels; interlocking edges, per manufacturer's recommendation.

1. Aluminum-Zinc Alloy Coated Steel: ASTM A792/A792M Commercial - CQ Quality, Coating Designation AZ 50 aluminum-zinc alloy coating. shop precoated with polyvinyl fluoride (PVF) coating. Exposed Exterior Surfaces: Color from manufacturer's standard range.

D. Miscellaneous Sheet Materials: Minimum 22 gage thick steel stock.

1. Aluminum-Zinc Alloy Coated Steel: ASTM A792/A792M Commercial - CQ Quality, Coating Designation AZ 50 aluminum-zinc alloy coating. shop precoated with polyvinyl fluoride (PVF) coating. Exposed Exterior Surfaces: Color from manufacturer's standard range.

E. Insulation: Glass fiber type specified in Section 07213 or pre-engineered metal building type specified in Section 07210.

F. Subgirts: Steel, manufacturer's standard profile; to attach panel system to structural frame. Thickness as required to support specified loads within specified deflection limitations.

G. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; brake formed to required angles.

H. Expansion Joints: Same material, thickness and finish as exterior sheets; manufacturer's standard brake formed type, of profile to suit system. Exposed fasteners same finish as panel system.

I. Trim, Closure Pieces, Caps, Flashings: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

J. Anchors: Stainless steel.

2.07 ACCESSORIES

A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient.

B. Sealants: Specified in Section 07900 color to match siding.

C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized; fastener cap same color as exterior panel.

D. Power Actuated Fasteners: Steel, hot dip galvanized; with soft neoprene washers, fastener cap same color as exterior panel.

E. Field Touch-up Paint: As recommended by panel manufacturer.

F. Bituminous Paint: Asphalt base.

2.08 FABRICATION

A. Form sections to shape indicated on Drawings, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest practicable lengths.

C. Panel Profile: Manufacturer's standard profile for specified system.

D. Fabricate corners in one continuous piece with minimum 18 inch returns.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01310 – Schedules and Reports: Coordination and project conditions.

B. Verify building framing members are ready to receive panel system.

3.02 INSTALLATION

A. Protect surfaces in contact with dissimilar metals with bituminous paint. Allow to dry prior to installation.

B. Fasten siding to structural supports; aligned, level, and plumb. Space fasteners maximum 24 inches on center either horizontally or vertically to suit application.

C. Locate joints over supports. Lap panel ends minimum 4 inches.

D. Install expansion joints where indicated.

E. Use concealed fasteners unless otherwise approved by Architect/Engineer.

F. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.03 ERECTION TOLERANCES

A. Section 01400 - Quality Control Services: Tolerances.

B. Maximum Offset From Indicated Alignment Between Adjacent Members Butting or In Line: 1/16 inch.

C. Maximum Variation from Plane or Location Indicated on Drawings: 1/8 inch.

3.04 CLEANING

A. Section 01700 - Contract Closeout: Final cleaning.

B. Remove site cuttings from finish surfaces.

C. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

END OF SECTION 07468

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Flashings and counter-flashings.

2. Other fabricated sheet metal items required to keep building weathertight and not specified elsewhere.

1.02 RELATED REQUIREMENTS

A. Section 410S - Concrete Structures: Placement of recessed and concealed reglets and accessories.

B. Section 06100 - Rough Carpentry: Wood blocking for metal roofing substrate profiles.

C. Section 07415 – Metal Roofing.

D. Section 07468 – Metal Siding: Flashings associated with wall panels.

E. Section 07714 - Gutters and Downspouts: Shop- or Site-fabricated metal rainwater gutters and downspouts.

F. Section 07900 - Joint Sealers: Sealants and sealers.

G. Section 09902 - Painting: Field painting.

H. Section 13120 – Metal Building Systems: Building framework to which flashings are attached.

1.03 REFERENCE STANDARDS

A. Aluminum Association:

1. AA - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association:

1. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

C. ASTM International:

1. ASTM A625/A625M - Standard Specification for Tin Mill Products, Black Plate, Single-Reduced.

2. ASTM A792 – Standard Specification for Steel Sheet, 55% Aluminum Zinc Alloy Coated by the Hot Dip Process.

3. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free.

D. Federal Specification Unit:

1. FS TT-C-494 - Coating Compound, Bituminous, Solvent Type, Acid Resistant.

E. National Roofing Contractors Association:

1. NRCA - Construction Details Manual.

F. Sheet Metal and Air Conditioning Contractors' National Association:

1. SMACNA - Architectural Sheet Metal Manual.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit manufacturer information regarding components metal types, finishes, and characteristics.

1. Select manufacturer’s standard color selector for finish selection.

C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

D. Samples:

1. After initial color selection by Architect, submit two samples, 8 by 8 inches in size, illustrating typical material and finish for final approval.

E. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate:

a. Certify that products meet or exceed specified sustainable design requirements.

b. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

1.07 COORDINATION

A. Section 01310 – Schedules and Reports: Requirements for coordination.

1.08 PREINSTALLATION MEETINGS

A. Section 01200 – Project Meetings: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

C. Meeting to be held in conjunction with preinstallation meetings for Sections 07415, 07468, and 07714.

D. Required attendees: Owner, Architect, General Contractor, and sub-contractors installing roofing, sheet metal trim, gutters.

1.09 QUALIFICATIONS

A. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:

1. Store materials according to manufacturer instructions.

2. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation.

3. Slope metal sheets to ensure drainage.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Prevent contact with materials that may cause discoloration or staining.

3. Provide additional protection according to manufacturer instructions.

1.11 NOT USED

PART 2 - PRODUCTS

2.01 SHEET METAL FLASHING AND TRIM

A. Performance and Design Criteria:

1. Sheet Metal Flashings: Reference Drawings for specific detailing.

2. Where specific details are not indicated in the Drawings, conform to typical detailing for condition indicated in SMACNA Manual.

2.02 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.03 MATERIALS

A. Pre-Finished Galvalume Steel Sheet:

1. Description:

a. Structural Steel Sheet.

b. Coating: AZ 50 aluminum-zinc coating.

2. Comply with ASTM A792/A792M

3. Thickness: 0.030 inch.

4. Coating:

a. Shop precoated with three-coat fluoropolymer in accordance with AAMA 2605.

b. Color: As selected from manufacturer's standard.

B. Pipe Flashing:

1. Description:

a. EPDM pre-molded pipe collar.

b. Flexible aluminum ring bonded to base of collar for securement.

2.04 FABRICATION

A. Form section shapes as indicated on Drawings, accurate in size, square, and free from distortion or defects.

B. Fabricate cleats of same material as sheet metal, interlocking with sheet.

C. Form pieces in longest possible lengths.

D. Hem exposed edges on underside 1/2 inch.

E. Miter and seam corners.

F. Forming:

1. Form material with standing seams, except where otherwise indicated.

2. At moving joints, use sealed, lapped, bayonet-type, or interlocking hooked seams.

G. Corners:

1. Fabricate corners from one piece with minimum 18-inch long legs.

2. Seam for rigidity and seal with sealant.

H. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

I. Flashings:

1. Fabricate flashings to allow toe to extend 2 inches over roofing.

2. Return and brake edges.

2.05 FINISHES

A. Fluoropolymer Coating:

1. Description: Multiple coats as specified for sheet metal system and thermally cured.

2. Comply with AAMA 2605.

3. Color to be selected to match exterior siding.

B. Washcoat: Finish concealed side of metal sheets with washcoat compatible with finish system, as recommended by finish system manufacturer.

2.06 ACCESSORIES

A. Fasteners: Same material and finish as flashing metal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for installation examination.

B. Verify that roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets are in place, and nailing strips have been located.

C. Verify that roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Section 01700 - Contract Closeout: Requirements for installation preparation.

B. Install starter strips, edge strips, and cleats before starting installation of sheet metal flashing and trim.

C. Paint concealed metal surfaces with protective backing paint to minimum dry film thickness of 15 mils.

3.03 INSTALLATION

1. Secure flashings in place using concealed fasteners.

2. Apply plastic cement compound between metal flashings and felt flashings.

3. Fit flashings tight in place, and make corners square, surfaces true and straight in planes, and lines accurate to profiles.

4. Seal metal joints watertight.

5. Pipe flashings: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

END OF SECTION 07600

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Gutters and downspouts.

2. Splash pads.

1.02 RELATED REQUIREMENTS

A. Section 07415 - Metal Roofing.

B. Section 07468 – Metal Siding: Exterior wall cladding adjacent to downspouts.

C. Section 07600 – Flashing and Sheet Metal.

D. Section 07900 - Joint Sealers: Sealants, sealers, and gaskets.

E. Section 13120 – Metal Building Systems: Metal framing system to which gutters and downspouts are secured.

1.03 REFERENCE STANDARDS

A. American Architectural Manufacturers Association:

1. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. ASTM International:

1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

2. ASTM A792 - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

C. Federal Specification Unit:

1. FS TT-C-494 - Coating Compound, Bituminous, Solvent Type, Acid Resistant.

D. National Roofing Contractors Association:

1. NRCA - The NRCA Roofing Manual.

E. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - Architectural Sheet Metal Manual.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit manufacturer information regarding components, materials, and finishes.

C. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.

D. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate:

a. Certify that products meet or exceed specified sustainable design requirements.

b. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

2) Certify source for regional materials and distance from Project Site.

1.07 COORDINATION

A. Section 01310 – Schedules and Reports: Requirements for coordination.

1.08 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

1.09 QUALITY ASSURANCE

A. Perform Work according to NRCA Roofing Manual.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:

1. Store materials according to manufacturer instructions.

2. Prevent contact with materials capable of causing discoloration, staining, or damage.

3. Slope to drain.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation.

3. Provide additional protection according to manufacturer instructions.

1.12 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

1.13 WARRANTY

A. Section 01700 - Contract Closeout: Requirements for warranties.

B. Furnish 20-year manufacturer's warranty for gutter and downspout finishes.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Sizing: Comply with applicable code for size and method of rainwater discharge or as indicated on the Drawings, whichever is larger.

2.02 GUTTERS AND DOWNSPOUTS

A. Description:

1. Gutters:

a. Material: Sheet metal.

b. Profile: Pre-engineered Building Manufacturer’s standard sculpted gutter profile.

2. Downspouts:

a. Material: Same metal type as gutters.

b. Profile: rectangular.

c. Size: 4 x 5 inches.

3. Splash Pads:

a. Material: Precast concrete.

b. Size: 12 by 24 inches.

c. Minimum Compressive Strength: 3,000 psi at 28 days.

d. Minimum Air Entrainment: 5 percent.

2.03 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content**.**

2.04 MATERIALS

A. Prefinished Galvalume-Steel Sheet:

1. Comply with ASTM A792; AZ50 aluminum-zinc coating.

2. Core Steel Thickness: 22 gage, 0.0300 inch.

3. Shop Precoat: Silicone-modified PVDF.

4. Color: As selected from manufacturer's standard.

2.05 FABRICATION

A. Forming of Sections:

1. Description:

a. Square and accurate in size.

b. Maximum possible lengths.

c. Free of distortion or defects detrimental to appearance or performance.

2. Shapes: As specified.

3. Allow for expansion at joints.

B. Fabricate with required connection pieces.

C. Hem exposed edges of metal.

D. Accessories: Seal watertight.

2.06 FINISHES

A. PVDF Coating:

1. Description: Multiple-coat, thermally cured, fluoropolymer system.

2. Comply with AAMA 2605.

B. Primer Coat: Finish concealed side of metal sheets with primer compatible with finish system, as recommended by finish system manufacturer.

2.07 ACCESSORIES

A. Anchors and Supports:

1. Profile: To suit gutters and downspouts.

2. Anchoring Devices: Comply with SMACNA.

3. Supports:

a. Gutters: Furnish brackets and straps.

b. Downspouts: Furnish brackets, straps.

B. Fasteners: Same material and finish as gutters and downspouts, with soft neoprene washers.

C. Primer Type: Zinc molybdate.

D. Protective Backing Paint: Bituminous, FS TT-C-494.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for installation examination.

B. Verify that surfaces are ready to receive gutters and downspouts.

3.02 PREPARATION

A. Section 01700 - Contract Closeout: Requirements for installation preparation.

B. Paint concealed metal surfaces and surfaces in contact with dissimilar metals using protective backing paint to minimum dry film thickness of 15 mils.

3.03 INSTALLATION

A. Sheet Metal:

1. Join lengths with formed seams, sealed watertight.

2. Flash and seal gutters to downspouts and accessories.

B. Minimum Gutter Slope: 1/8 inch per foot.

C. Seal connections watertight.

D. Set splash pads under downspouts, and secure in place.

a)

END OF SECTION 07714

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Preparing substrate surfaces.

2. Sealant and joint backing.

1.02 RELATED REQUIREMENTS

A. Section 06100 – Rough Carpentry: Sheathing assemblies where sealant is required.

B. Section 07160 – Sheet Vapor Retarders: Sealants required in conjunction with vapor retarders.

C. Section 07415 – Metal Roofing.

D. Section 07468 – Metal Siding.

E. Section 07600 – Flashing and Sheet Metal.

F. Section 07714 – Gutters and Downspouts.

G. Section 08110 – Steel Doors and Frames.

H. Section 08410 – Metal Framed Storefronts.

I. Section 08800 - Glazing: Glazing sealants and accessories.

J. Section 09260 - Gypsum Board Assemblies: Acoustic sealant.

K. Section 12346 Laboratory Work Surfaces.

L. Section 12355 Metal Laboratory Casework.

1.03 REFERENCES

A. ASTM International:

1. ASTM C510 – Standard Test Method for Staining and Color Change of Single or Multicomponent Joint Sealants.

2. ASTM C711 – Standard Test Method for Low Temperature Flexibility and Tenacity of One Part, Elastomeric, Solvent Release Type Sealants.

3. ASTM C834 - Standard Specification for Latex Sealants.

4. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.

5. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

6. ASTM C1193 - Standard Guide for Use of Joint Sealants.

7. ASTM C1247 – Standard Test Method for Durability of Sealants Exposed to Continuous Immersion in Liquids.

8. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.

9. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness.

10. ASTM D3574 – Standard Test Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams.

11. ASTM E90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

12. ASTM E283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtains walls, and Doors Under Specified Pressure Differences Across the Specimen.

13. ASTM E330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

14. ASTM E331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

B. California Department of Health Services:

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

C. FDA Regulation CFR Title 21, Chapter 1, Subchapter B, Section177.2600 – Indirect Food Additives: Polymers – Rubber articles intended for repeated use.

D. NSF/ANSI Standard 61 – Drinking Water System Components.

E. South Coast Air Quality Management District:

1. SCAQMD Rule 1168 - Adhesive and Sealant Applications.

F. Underwriters Laboratory:

1. UL 2079 – Standard for tests for Fire Resistance of Building Joint Systems.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Submittal procedures.

B. Products Data: Submit data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

C. Samples: Submit two samples, size illustrating sealant colors for selection.

D. Manufacturer's Installation Instructions: Submit special procedures, surface preparation, and perimeter conditions requiring special attention.

E. Warranty: Include coverage for installed sealants and accessories failing to achieve airtight seal, watertight seal, exhibit loss of adhesion or cohesion, and sealants which do not cure.

F. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

3. Certify source for regional materials and distance from Project site.

a. Indoor Air Quality Certificates:

4. Certify volatile organic compound content for each interior adhesive and sealant and related primer.

1.07 QUALITY ASSURANCE

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform acoustical sealant application work in accordance with ASTM C919 and ASTM C1193, as appropriate to condition.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 01600 – Materials and Equipment.

B. Maintain temperature and humidity recommended by sealant manufacturer during and after installation.

1.10 COORDINATION

A. Section 01310 – Schedules and Reports: Coordination and project conditions.

B. Coordinate Work with sections referencing this section.

PART 2 - PRODUCTS

2.01 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

1. Indoor Environmental Quality Characteristics:

    a. Adhesives and Sealants: Maximum volatile organic compound content in accordance with product and testing requirements of CA/DHS/EHLB/R-174.

2. Indoor Environmental Quality Characteristics:

    a. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

2.02 MANUFACTURERS

A. Manufacturers: One of the following or approved equal:

1. BASF Sonneborn.

2. Dow Corning.

3. Sika.

4. Pacific Polymers.

5. BASF Watson Bowman Acme.

2.03 MATERIALS – GENERAL

A. Compatibility: Provide joint sealants, backings and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content: Provide all interior sealants and sealant primers that comply with the SCAQMD Rule 1168.

C. Colors of Exposed Joint Sealants: As selected by ENGINEER from manufacturer's full range of colors.

2.04 TYPE A: SYNTHETIC RUBBER SEALING COMPOUND

A. Manufacturer: One of the following or equal:

1. Sika Corporation, Lyndhurst, NJ, Sikaflex 2c NS or SL

2. Pacific Polymers, Garden Grove, CA, Elastothane 227R.

B. Material: In accordance with ASTM C 920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient rubber; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:

1. Base: Polyurethane rubber.

2. Solids: Minimum 97 percent.

3. Application time: Minimum 2 hours.

4. Cure time: Maximum 3 days.

5. Tack free time: 24 hours.

6. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.

7. Tensile strength: Non-sag 120 pounds per square inch minimum and Self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D 412.

8. Ultimate elongation: Minimum 490 percent when tested in accordance with ASTM D 412.

9. Tear resistance: Non-sag 45 pounds per inch minimum and Self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D 624, Die C.

10. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.

C. Color: Gray to match concrete, unless indicated on the Drawings.

2.05 TYPE B: SINGLE COMPONENT NEUTRAL CURING SILICONE SEALANTS

A. BASF Sonneborn – Omniseal 50; Type S (single component), Grade NS (nonsag), Use NT (nontraffic), M, A, G and O; VOC content <250 g/L.

2.06 SYNTHETIC SPONGE RUBBER FILLER

A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. Manufacturers: One of the following or equal:

1. Presstite, Number 750.3 Ropax Rod Stock.

2. Rubatex Corp., Rubatex-Cord.

B. Characteristics:

1. Suitable for application intended.

2. Strength: As necessary for supporting sealing compound during application.

3. Resiliency: Sufficient resiliency to prevent significant load transfer across joint.

4. Resistance to environmental conditions of installation.

5. Bonding: No bonding to the sealing compound.

6. Structure: Cellular, prevents wicking or absorption of water.

7. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.

8. Size: Minimum 25 percent greater than nominal joint width.

2.07 NEOPRENE RUBBER SEAL

A. Manufacturer: One of the following or approved equal:

1. BASF Watson Bowman Acme; Jeene Expansion Joint Sealant System:

a. Horizontal applications: FW-Series profile.

b. Vertical applications: W-Series profile.

B. The structural sealing joint profile shall be preformed and manufactured from an extruded neoprene compound exhibiting the physical properties listed below:

1. Tensile Strength: 2,000 psi.

2. Elongation at break: 250%, min.

3. Hardness, Type A Durometer: 65 +/- 5%.

    a. Low temp stiffening 7 days @ 14ºF: 0-15.

4. Oven aging 70 hrs @ 212 degrees F.

    a. Tensile strength: 20% loss max.

    b. Elongation: 20% loss max.

    c. Hardness: 0 to 10 points.

5. Oil Swell, 70 hrs @ 104 degrees F: 45%.

6. Ozone Resistance: No cracks.

C. Adhesive: elastomeric seal shall be installed utilizing a two-component epoxy based adhesive which meets the following requirements:

1. Tensile Strength: 4,000 psi.

2. Compressive Strength: 8,000 psi.

3. Solids hardness: 5 mohs.

4. Pot life: 40 minutes at 68 degrees F.

5. Flash Point: Greater than 200 degrees F.

6. Initial Cure: 24 hours.

7. Fill Cure: 7 days at 68 degrees F.

D. For use at expansion joints larger than 1-inch where called for on Drawings as "Neoprene Rubber Seal".

2.08 RELATED MATERIALS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01310 – Schedules and Reports: Coordination and project conditions.

B. Verify substrate surfaces and joint openings are ready to receive work.

C. Verify joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

A. Remove loose materials and foreign matter impairing adhesion of sealant.

B. Clean and prime joints.

C. Perform preparation in accordance with ASTM C1193.

D. Protect elements surrounding Work of this section from damage or disfiguration.

3.03 INSTALLATION

A. Perform installation in accordance with ASTM C1193.

B. Perform acoustical sealant application work in accordance with ASTM C919.

C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer , except where specific dimensions are indicated.

D. Tool butt joints concave. Tool fillet joints triangularly (straight not concave).

E. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

F. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 CLEANING

A. Section 01700 - Contract Closeout: Final cleaning.

B. Clean adjacent soiled surfaces.

3.05 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01700 - Contract Closeout: Protecting installed construction.

B. Protect sealants until cured

3.06 SCHEDULE

A. This Schedule indicates only some of the major items requiring sealant, and is not intended to be all inclusive.

	Location	Type	Color
A.	Window perimeter (Exterior & unconditioned interior areas)	A	Match masonry grout at locations adjacent to masonry Match steel trim color at locations adjacent to steel
B.	Door Frame/Walls (Exterior & unconditioned interior areas)	A	Match masonry grout at locations adjacent to masonry Match steel trim color at locations adjacent to steel
C.	Door Frame/Walls (Interior)	B	White (paintable) adjacent to gyp bd
D.	Window Frame/Walls (Interior)	B	White (paintable) adjacent to gyp bd
E.	Under Thresholds	B	Black
F.	Concrete Joints	A	Grey (SL Horizontal; NS Vertical)
G.	Gypsum System	B	White (paintable)
H.	Masonry Control Joints	A	Match wall color (paintable)
I.	Masonry Expansion Joints	A	Match wall color (paintable)

END OF SECTION 07900

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Steel Non-Fire Resistive Rated:

1. Doors.

2. Door frames.

3. Combination door frames and transom bars.

1.02 RELATED REQUIREMENTS

A. Section 06100 – Rough Carpentry: Placement and anchoring in framed walls and partitions.

B. Section 07468 – Metal Siding: Adjacent finish materials.

C. Section 08710 - Door Hardware: Hardware, silencers, and weatherstripping.

D. Section 08800 - Glazing.

E. Section 09260 – Gypsum Board Assemblies: Placement and anchoring in framed partitions.

F. Section 13120 – Metal Building Systems: Metal framework for placement and anchoring of door frames.

1.03 REFERENCES

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

B. American National Standards Institute (ANSI):

1. A250.6 - Hardware on Steel Doors (Reinforcement Application).

2. A250.8 - Recommended Specification for Standard Steel Doors and Frames.

C. American Society for Testing and Materials (ASTM):

1. A 366 - Standard Specification for Steel, Sheet, Carbon, Cold-Rolled Commercial Quality.

2. A 569 Standard Specification for Steel, Carbon (0.5 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality.

3. A 653/A653M - Standard Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

4. A 924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic- Coated by the Hot-Dip Process.

5. E 413 - Classification for Rating Sound Insulation.

6. E 1408 - Standard Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems.

D. National Association of Architectural Metal Manufacturers (NAAMM)/Hollow Metal Manufacturers Association (HMMA):

1. HMMA 861 - Guide Specifications For Commercial Hollow Metal Doors and Frames.

E. Steel Door Institute (SDI):

1. SDI-111 - A Steel Doors and Frame Details.

2. SDI-117 - Manufacturing Tolerances Standard Steel Doors and Frames.

F. Hollow Metal Manufacturers Association:

1. HMMA 810 - Hollow Metal Doors.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Submittal procedures.

B. Shop Drawings: Indicate frame elevations, reinforcement, anchor types and spacing, location of cut-outs for hardware, and finish.

C. Product Data: Submit frame configuration and finishes.

D. Manufacturer's Installation Instructions: Submit special installation instructions.

E. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Approved by ultimate enforcing authority for the Project; regularly engaged in inspection of materials and workmanship at factory.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Product storage and handling requirements.

B. Accept frames on site in manufacturer's packaging. Inspect for damage.

C. Break seal on-site to permit ventilation.

1.10 COORDINATION

A. Section 01310 – Schedules and Reports: Coordination and project conditions.

B. Coordinate Work with frame opening construction, door, and hardware installation.

C. Sequence installation to accommodate required door hardware electric wire connections as indicated in Section 08710.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sheet Steel: ASTM A 366, commercial quality, level, cold rolled steel, or ASTM A 569, hot rolled, pickled and oil rolled steel. Galvanize by hot-dip process with zinc-coating conforming to ASTM A 653 and A 924, with a coating weight of not less than 0.90 ounces per square foot (0.45 ounces per square foot per side). Clips, Bolts, Screws, and Rivets: Sized as recommended by manufacturer.

B. Primer: Rust- inhibitive metal primer capable of being baked and compatible with finish painting system specified in Section 09902 - Painting.

C. Touch-Up Materials: Primer as recommended by manufacturer.

D. Door Hardware: As specified in Section 08710 - Door Hardware.

E. Glass and Glazing Materials: As specified in Section 08800 - Glazing.

F. Bituminous Coating: Non-asbestos fibered asphalt emulsion.

2.02 SUSTAINABILITY CHARACTERISTICS

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.03 DOOR AND FRAME TYPES

A. Interior Doors: ANSI 250.8, Grade III, Model 3 or NAAMM HMMA 810 Type A and NAAMM HMMA 861, flush steel rib-stiffened, minimum 18 gauge face sheets.

1. Insulated core.

B. Exterior Doors: ANSI 250.8, Grade III, Model 3, or NAAMM HMMA 810 Type A and NAAMM HMMA 861, flush steel rib-stiffened, minimum 16 gauge face sheets.

1. Insulated core.

C. Interior Frames: ANSI 250.8 or NAAMM HMMA 861, fully welded frames, minimum 16 gauge, sizes and shapes as indicated on the Drawings.

D. Exterior Frames: ANSI 250.8 or NAAMM HMMA 861, fully welded frames HMMA 861, except minimum 14 gauge sizes and shapes as indicated on the Drawings.

2.04 COMPONENTS

A. Door Cores:

1. Stiffeners: Vertical steel ribs formed from minimum 22-gauge plain sheet steel, spaced at maximum 6 inches apart and securely attached to face sheets by spot welds at maximum 5 inches on center.

2. Core Fillers: Insulation, minimum 0.60 pound density noncombustible type, installed in spaces between stiffeners for full height of door; labeled door core material shall conform to requirements of labeling authority.

a. All doors shall have insulation core fillers.

B. Glazing Stops: Minimum 18 gauge sheet steel, mitered, square or rectangular:

1. Outside of Exterior Doors: Fixed, integral to doors and frames.

2. Secure Side of Interior Doors: Removable.

C. Removable Stop Fasteners: Flat head, countersunk, tamperproof, self-tapping sheet metal screws.

2.05 FABRICATION OF FRAMES

A. Galvanize all frames.

B. Frames: Sheet steel, integral type, welded continuous to full depth of frames with minimum 5/8-inch deep stops, unless otherwise indicated on the Drawings.

C. Hardware Reinforcement: Minimum 7 gauge at hinges; 12 gauge at strikes, bolts, closers, and other applied hardware.

D. Jamb Anchors: As required for adjacent wall construction, minimum 3 per jamb, unless otherwise indicated on the Drawings.

E. Floor Anchors: Fixed type, except where adjustable anchors are indicated on the Drawings, 1 per jamb, with minimum 2 holes for anchorage. Where floor fill occurs, terminate bottom of frames at indicated finished floor level and support by adjustable extension clips resting on and anchored to structural slabs.

F. Anchors at Previously Placed Concrete: Countersink machine screws through the frame into expansion devices spaced at maximum 30 inches on center.

G. Anchors at Structural Steel Framing: Welded or otherwise securely fastened with stainless steel screws.

H. Masonry Angle Stiffeners: Factory welded into heads of frames for installation in openings more than 48 inches wide.

I. Mullions, Muntins, and Transom Bars: Minimum 18 gauge, tubular sheet steel matching, and butt-welded to, head and jamb members.

J. Removable Stops: Fasten at approximately 12 to 16 inches on center.

K. Shop Finishing:

1. Steel Sheet: Galvanized to ASTM A653/A653M G90.

2. Primer: Baked.

3. Factory Finish: Baked prime paint over phosphatized steel.

4. Coat inside of frame profile at exterior doors with bituminous coating to minimum thickness of 1/16 inch

2.06 FABRICATION OF DOORS

A. Galvanize all doors.

B. Reinforce face sheets with steel rib stiffeners, spaced at maximum 6 inches apart, and securely attached to face sheets by spot welds at maximum 5 inches on center.

C. Fill voids between face sheets and stiffeners with fiberglass insulation having a minimum density of 0.8 pounds per cubic foot.

D. Edges: Full weld without visible joints. Bevel striking edge 1/8 inch in 2 inches.

E. Tops and Bottoms of Doors: Close with continuous recess steel channel of minimum 16 gauge, extending full width of door and spot welded to both faces.

F. Tops and Bottoms of Exterior Doors: Flush closing channels welded to make tops and bottoms waterproof with weep holes for escape of moisture.

G. Hinge Reinforcement: 7 gauge.

H. Lock, Closer, and Flush Bolt Reinforcement: 12 gauge.

I. Astragals:

1. Install on active leaf of double doors.

2. Do not provide astragal cutouts for hardware operations.

J. Astragal Clearances Doors:

1. Door bottoms at threshold: Not to exceed 3/8 inch between threshold and door bottom.

2. Door bottoms where there is no threshold: Maximum clearance between door and floor not to exceed 1/2 inch.

3. Door bottoms at doors designated to receive floor coverings: Not to exceed 1/2 inch between floor covering and door bottom.

4. Clearance between door and frame and between meeting edges of pairs of doors: Not to exceed 1/8 inch.

K. Glazing: Insulated at all exterior doors. Insulated at interior doors where door separates conditioned and unconditioned space.

2.07 HARDWARE PREPARATION

A. Cut-out, drill, and reinforce frames and doors for hardware in accordance with hardware templates.

B. Install plaster guards or mortar boxes in back of hardware cut-outs in and welded to frames.

C. Do not weld hinges to doorframes.

D. Silencers:

1. Drill single leaf doorframe jamb stops for minimum 3 silencers.

2. Drill double-leaf doorframe head stops for minimum 2 silencers.

3. Do not drill doorframes for silencers when weatherstripping is to be installed.

2.08 SHOP FINISHING

A. Thoroughly clean surfaces of oil, grease, and other impurities; touch-up abraded galvanizing; and chemically etch.

B. Fill irregularities and sand smooth finish surface. Apply 1 coat of manufacturer's standard rust inhibitive baked-on primer.

C. Finish Painting: As specified in Section 09902 - Painting.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine reviewed hardware schedules and verify proper coordination of hardware and doors and frames.

B. Examine opening locations and verify the following:

1. Correctness of dimensions, backing or support conditions.

2. Absence of defects that would adversely affect frame or door installation.

3.02 INSTALLATION

A. Install doors and frames in accordance with approved shop drawings and manufacturer's instructions.

B. Frames:

1. Set accurately in position, plumb, align, and attach securely to structure.

2. Set in place before construction of adjacent masonry or framed walls.

3. Anchor frames to previously placed concrete.

4. Set frames before removing spreader bars.

5. Fully grout frames in masonry as the Work progresses.

6. Grout frames at concrete through keyways provided at head and jambs.

C. Doors: Install at correct openings, ensure smooth swing and proper closure with frame.

D. Door Hardware: Install in accordance with Section 08710 – Door Hardware.

E. Separate or isolate dissimilar metals with neoprene gaskets, sleeves, and washers, or with coatings acceptable to the Engineer.

3.03 ERECTION TOLERANCES

A. Section 01400 - Quality Control Services: Tolerances.

B. Manufacturing and Installation Tolerances: As indicated on the Drawings or in conformance to SDI 117 as minimum.

3.04 ADJUSTING AND CLEANING

A. Prime Coat Touch-Up: Immediately after installation, sand smooth and touch-up rust areas and other areas where primer has been damaged, with prime touch-up paint.

B. Make adjustments as required for correct, proper, and free function and smooth operation without binding of hardware or doors and frames.

C. Protect doors and frames from damage to surface or profile.

3.05 SCHEDULE

A. Refer to Door and Frame Schedule in Drawings for additional information.

END OF SECTION 08114

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Overhead coiling doors.

2. Operating hardware.

3. Manual operation.

1.02 RELATED REQUIREMENTS

A. Section 07900 – Joint Sealers: Sealants and backing materials.

B. Section 08710 – Door Hardware: Product requirements for cylinder core and keys for placement by this section.

C. Section 09902 – Painting & Protective Coatings: Field paint finishes.

D. Section 13120 – Metal Building System: Support framing and framed opening.

1.03 REFERENCE STANDARDS

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

B. ASTM International:

1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

4. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

C. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

D. UL:

1. UL - Building Materials Directory.

2. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

3. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit general construction details, component connections.

C. Shop Drawings: Indicate relevant dimensioning, anchorage methods, hardware locations, and installation details for applicable supporting wall construction.

D. Samples: Submit two slats, 12 by 12 inches in size, illustrating shape, color, and finish texture.

E. Manufacturer Instructions: Submit installation sequence and procedures, and adjustment and alignment procedures.

F. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate:

a. Certify products meet or exceed specified sustainable design requirements.

b. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

1.07 QUALITY ASSURANCE

A. Labels:

1. Identification: Attach label from agency approved by authority having jurisdiction to identify each fire-rated door.

2. Oversize Door Certification: Furnish UL Certificate of Inspection, or comparable certification acceptable to authority having jurisdiction, in lieu of label for oversize door assemblies exceeding 120 sq. ft. or 24 feet in any dimension.

B. Fire-Rated Door Assemblies: Comply with NFPA 80 for fire-rated class as scheduled.

C. Smoke Protected Door Assemblies: Comply with UL label for "Leakage Rated Assembly" or "S" label.

1. Comply with NFPA 105 air leakage requirements.

2. Pass UL test procedure 1784.

D. Products Requiring Electrical Connection: Listed and classified by UL or another testing firm acceptable to authority having jurisdiction.

E. Surface-Burning Characteristics:

1. Foam Insulation: Maximum 75/450 flame-spread/smoke-developed index when tested according to ASTM E84.

F. Ozone Depletion Potential (ODP):

1. Foam Insulation: ODP of zero; chlorofluorcarbon free.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01700 - Contract Closeout: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for overhead coiling doors.

C. Furnish ten-year manufacturer's warranty against delamination of polyurethan foam insulation from the steel skin of overhead coiling doors.

D. Furnish twenty-year manufacturer's finish warranty for slat finishes.

PART 2 - PRODUCTS

2.01 OVERHEAD COILING DOORS

A. Manufacturers:

1. DBCI, Douglasville, GA.

    a. Model 3100 insulated as basis of design.

2. Or approved equal.

2.02 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.03 DESCRIPTION

A. Manual Operation:

1. Operator: Hand-chain lift, with overhead counterbalance device.

2. Nominal Required Force: 25 lbf.

B. Curtain:

1. 26-gauge galvanized corrugated steel.

2. Insulated, R-4.

3. Draft stops to prevent air and moisture infiltration.

4. Aluminum bottom bar fitted with aluminum angles, channels, or hollow extrusion to provide reinforcement and to maintain positive contact with floor in closed position with stainless steel fasteners.

C. Guides:

1. Description:

    a. Rolled galvanized steel track.

    b. Configuration: Continuous.

2. Minimum Thickness: 0.0747 inch.

3. Mounting:

a. Orientation: Vertical.

b. Brackets: Galvanized steel.

D. Roller Shaft Counterbalance:

1. Description:

a. 11 gauge steel pipe capable of supporting curtain load with maximum deflection of 0.03 in./ft. of width.

b. Steel spring system capable of producing torque sufficient to ensure smooth operation of curtain from any position, and capable of holding position at mid-travel.

E. Hardware:

1. Locks: As specified in Section 08710 - Door Hardware.

2.04 COMPONENTS

A. Overhead coiling doors:

1. Basis of Design: DBCI 3100 Series Insulated.

2.05 FINISHES

A. Precoated Paint Finish:

1. Type: Manufacturer's standard.

2. Color: As selected.

2.06 ACCESSORIES

A. Chain Keeper: Manufacturer's standard.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for installation examination.

B. Verify that opening sizes, tolerances, and conditions are acceptable.

C. Verify that supplementary support framing installed under other Sections is ready to receive doors.

3.02 INSTALLATION

A. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

B. Securement:

1. Securely and rigidly brace components suspended from structure.

2. Secure guides to structural members only.

C. Fit and align assembly, including hardware, level and plumb to provide smooth operation.

D. Sealants and Backing Materials: As specified in Section 07900 - Joint Sealers.

E. Install perimeter trim and closures.

3.03 TOLERANCES

A. Section 01400 - Quality Control Services: Requirements for tolerances.

B. Maintain dimensional tolerances and alignment with adjacent Work.

C. Maximum Variation from Plumb: 1/16 inch.

D. Maximum Variation from Level: 1/16 inch.

E. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 feet straight edge.

3.04 FIELD QUALITY CONTROL

A. Section 01700 - Contract Closeout: Requirements for testing, adjusting, and balancing.

B. Testing:

1. Test for proper operation.

C. Adjust door, hardware, and operating assemblies for smooth and noiseless operation.

D. Clean door and components.

E. Remove labels and visible markings.

3.05 ADJUSTING

A. Section 01700 - Contract Closeout: Requirements for starting and adjusting.

B. Adjust door, hardware, and operating assemblies for smooth and noiseless operation.

3.06 CLEANING

A. Section 01700 - Contract Closeout: Requirements for cleaning.

B. Clean door and components.

C. Remove labels and visible markings.

END OF SECTION 08830

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Aluminum-framed storefronts.

1.02 RELATED REQUIREMENTS

A. Section 06100 – Rough Carpentry: Wood blocking.

B. Section 07468 – Metal Siding: Exterior siding abutting substrate.

C. Section 07900 - Joint Sealers: System perimeter sealant and backup materials.

D. Section 08800 - Glazing: Exterior and interior glazing materials and methods.

E. Section 09260 – Gypsum Board Assemblies: Abutting substrates.

F. Section 12494 – Roller Shades.

G. Section 13120 - Metal Building Systems: Pre-engineered metal building.

1.03 REFERENCE STANDARDS

A. American Architectural Manufacturers Association/Window & Door Manufacturers Association:

1. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

2. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.

3. AAMA 612 - Voluntary Specification, Performance Requirements, and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum.

4. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

5. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.

6. AAMA MCWM-1 - Metal Curtain Wall Manual.

7. AAMA SFM-1 - Aluminum Storefront and Entrance Manual.

B. American Society of Civil Engineers:

1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

C. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

3. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

4. ASTM E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

5. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

6. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

7. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.

8. ASTM E1886 - 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.

9. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

D. California Department of Public Health:

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

E. Green Seal:

1. GC-03 - Green Seal Environmental Criteria for Anti-Corrosive Paints.

F. International Energy Conservation Code:

1. IECC Climate Zone Map.

G. SSPC: The Society for Protective Coatings:

1. SSPC Paint 20 - Zinc-Rich Coating (Type I - Inorganic and Type II - Organic).

2. SSPC Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel (Type I and Type II).

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit component dimensions, description of components within assembly, anchorage and fasteners, glass, finished brake metal, and internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, and expansion and contraction joint location and details.

D. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for structural framing member, physical characteristics, and dimensional limitations.

E. Manufacturer Instructions: Submit storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:

1. Submit manufacturer's approval of installer.

H. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate:

a. Certify that products meet or exceed specified sustainable design requirements.

b. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

c. Indoor Air Quality Certificates: Certify VOC content for each interior adhesive, sealant, and related primer.

1.07 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with installation of air barrier, vapor retarder, components or materials.

C. Verify that field measurements are as indicated on the shop drawings.

D. Coordinate work of this section with installation of glass/glazing specified in Section 08800 and door hardware specified in Section 08710.

1.08 QUALITY ASSURANCE

A. Perform Work according to AAMA SFM-1.

1.09 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Texas.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Handling: Comply with AAMA CW-10.

D. Store products according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect finished aluminum surfaces with strippable coating.

3. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

4. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Do not install sealants or glazing materials if ambient temperature is less than 40 deg. F during and 48 hours after installation.

1.12 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

1.13 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish three-year minimum manufacturer's warranty for aluminum framing components and assemblies.

C. Include coverage for complete system for failure to meet specified requirements.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Aluminum-framed, shop-fabricated, and factory-finished storefront system with tubular aluminum sections.

B. Furnish systems with glass and glazing as specified in Section 08 80 00, related flashings, anchorages, and attachment devices.

C. System Assembly: Shop-unitized.

2.02 PERFORMANCE AND DESIGN CRITERIA

A. System Design:

1. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall, including building corners.

2. Testing: Comply with ASTM E330/E330M.

3. Calculation:

a. Comply with ASCE 7.

B. Windborne Debris Loads:

1. Design and size glass located less than 60 feet above grade to withstand following loads:

a. Glass within 30 Feet of Grade: Comply with ASTM E1886 and ASTM E1996; large-missile impact test.

b. Glass Greater Than 30 Feet above Grade: Comply with ASTM E1886 and ASTM E1996; small-missile impact test.

C. Deflection:

1. Framing Deflection Limit: 1/175 for spans under 13-1/2 feet and 1/240 plus 1/4 inch for spans over 13-1/2 feet.

2. Ensure full recovery of glazing materials.

D. System Assembly: Without damage to components or deterioration of seals, accommodate movement within system, movement between system and peripheral construction, dynamic loading and release of loads, and deflection of structural support framing.

E. Air Infiltration:

1. Maximum through Assembly: 0.06 cfm /sq. ft. of wall area.

2. Reference Differential Pressure across Assembly:

a. 6.24 psf.

b. Measurement: Comply with ASTM E283.

F. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily inline with inside pane of glass and heel bead of glazing compound.

G. Condensation-Resistance Factor: Not less than 45 when measured according to AAMA 1503.

H. Water Leakage:

1. None.

2. Measurement:

a. Comply with ASTM E331.

b. Test Pressure Difference: 10 psf.

I. Thermal and Solar Heat Transmittance of Assembly (U-Value and Solar Heat Gain Coefficient): Comply with IECC for climate zone in which Project is located.

J. Expansion/Contraction: Ensure that system components can withstand expansion and contraction caused by minimum cycling temperature range of 170 deg. F over a 12-hour period, without causing detrimental effect to system components or anchorage.

K. System Internal Drainage: Furnish weep drainage network to drain water to exterior, including water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system.

2.03 MANUFACTURERS

A. Storefronts

1. Kawneer Company, Inc., Norcross, GA.

2. EFCO, Monett, MO.

3. YKK, Atlanta, GA.

4. Or approved equal.

2.04 MATERIALS

A. Extruded Aluminum: ANSI/ASTM B221; 6063 alloy, T5 temper.

B. Sheet Aluminum: ANSI/ASTM B209.

C. Sheet Steel: ANSI/ASTM A446 galvanized.

D. Steel Sections: ANSI/ASTM A36; shaped to suit mullion sections.

E. Fasteners: Stainless steel.

F. Shop and Touch-Up Primer for Steel Components: SSPC 15, Type 1, red oxide.

G. Touch-Up Primer for Galvanized Steel Surfaces: SSPS 20, zinc rich type.

H. Glazing Materials as indicated:

I. Gaskets for doors and frames shall be EPDM extrusions.

1. Glass and Exterior: 1-inch Insulated pane and sealed.

2. See Section 08800.

J. Sealant and Backing Materials: As specified in Section 07900 - Joint Sealers.

2.05 COMPONENTS

A. Window framing:

1. Basis of Design: Kawneer VG 451T Thermal Multi-Plane.

a. Vertical and horizontal framing members shall have a nominal face dimension of 2 inches.

b. Overall depth shall be 4-1/2 inches with appropriate glass pocket width for Insulated Glass Units.

c. Glass Pocket Position: Center Plane.

2.06 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

C. Indoor Environmental Quality Characteristics:

1. Interior Anticorrosive Paints: Maximum VOC content according to GC-03.

2.07 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Arrange fasteners and attachments to conceal from view.

E. Reinforce framing members for imposed loads.

2.08 FINISHES

A. Exterior and Interior facing components of Aluminum Storefronts, Window Wall and Window assemblies.

B. Color: Clear Anodic coating electrolytically deposited to:

1. Class I, AA-M12C22A44 (AAMA 611) anodized to 0.7-mil thickness, prepared with a mechanical M12 and Chemical C22 pre-treatment; Clear anodized color; OR

2. AAMA 612.

C. Concealed Steel Items: Galvanized in accordance with ANSI/ASTM A386 to 2.0 oz/sq feet.

D. Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for installation examination.

B. Verify dimensions, tolerances, and method of attachment with other Work.

C. Verify that wall openings and adjoining air and vapor seal materials are ready to receive Work of this Section.

3.02 INSTALLATION

A. Comply with AAMA SFM-1 - Aluminum Storefront and Entrance Manual.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist.

E. Maintain assembly dimensional tolerances.

F. Provide thermal isolation where components penetrate or disrupt building insulation.

G. Install continuous aluminum thermally broken back fillers.

H. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

I. Sill Flashings:

1. Turn up ends and edges.

2. Seal to adjacent Work to form watertight dam.

J. Coordinate attachment and seal of perimeter air and vapor retarder materials.

K. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

L. Install integral flashings and integral joint sealers.

M. Set sills and thresholds in bed of mastic and secure.

N. Glass:

1. As specified in Section 08800 - Glazing.

2. Separate glass from metal surfaces.

O. Perimeter Sealants: As specified in Section 07900 - Joint Sealers.

3.03 TOLERANCES

A. Section 01400 - Quality Control Services: Requirements for tolerances.

B. Maximum Variation from Plumb: 0.06 in./3 ft. noncumulative, or 1/16 in./10 ft., whichever is less.

C. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

A. Section 01400 - Quality Control Services: Requirements for inspecting and testing.

1. Field Testing: Comply with AAMA 503 for both air infiltration and water penetration.

a. Air infiltration ASTM E783:

1) Test at 1.57 psf.

2) Maximum leakage: 1.5 times the amount indicated in the performance requirement or 0.09 cfm/sf of area tested, whichever is greater.

b. Water penetration: ASTM E1105, procedure a.

1) Test pressure: Static test pressure of two-thirds the specified water penetration pressure but not less than 6.24 psf.

2) Maximum leakage: None.

c. Areas to be Tested:

1) Testing shall be performed at a single location. Test(s) shall be conducted of fully installed condition.

B. Section 01700 – Contract Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

2. Make final adjustments under direction of manufacturer's representative.

3.05 ADJUSTING

A. Section 01700 - Contract Closeout: Requirements for starting and adjusting.

B. Adjust operating hardware for smooth operation.

3.06 CLEANING

A. Section 01700 - Contract Closeout: Requirements for cleaning.

B. Remove protective material from prefinished aluminum surfaces.

C. Surfaces:

1. Wash down with solution of mild detergent in warm water.

2. Apply with soft, clean wiping cloths.

3. Wipe surfaces clean.

D. Remove excess sealant by method acceptable to sealant manufacturer.

3.07 PROTECTION

A. Section 01700 - Contract Closeout: Requirements for protecting finished Work.

B. Protect finished Work from damage.

END OF SECTION 08410

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PART 1 - GENERAL

1.01 SUMMARY

A. Section includes hardware for steel doors.

1. Provide door gaskets, including weatherstripping and seals, and thresholds.

1.02 RELATED REQUIREMENTS

A. Section 08110 – Steel Doors and Frames: Silencers integral with steel frames.

B. Section 08330 – Architectural Overhead Coiling Doors.

C. Section 10400 - Signage.

D. Section 13122 – Metal Building Systems.

1.03 REFERENCES

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

B. ASTM International (ASTM):

1. E 90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

2. E 283 – Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

C. Builders Hardware Manufacturers Association (BHMA):

1. A 156.7 – Template Hinge Dimensions.

2. A 156.18 – Hardware – Materials and Finishes.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Submittal procedures.

B. Product Data:

1. Provide product data in the form of a binder, manufacturer’s technical product fact sheets for each item of hardware. Include whatever information may be necessary to show compliance with requirements, including instructions for installation and for maintenance of operating parts and finish.

C. Hardware Schedule including the following in vertical format:

1. Heading Number/Hardware Set.

2. Door Number, Location, Hand, Degree of Opening, Door Size and Type, Frame Size and Type, Fire Rating.

3. Quantity, type, style, function, product, product number, size, fasteners, finish and manufacturer of each hardware item.

4. Location of hardware set cross-referenced to indications on Drawings both on floor plans and in door and frame schedule.

5. Keying schedule.

6. Title Sheet, Index, Abbreviations, Manufacturers List, Template List and Templates.

7. Mounting locations for hardware.

8. Explanation of abbreviations, symbols, and codes contained in schedule.

D. Manufacturer's Installation Instructions: Submit special procedures, and perimeter conditions requiring special attention.

E. Keying Schedule: A keying schedule shall be submitted using keyset symbols referenced in DHI manual “Keying Systems and Nomenclature." The keying

schedule shall be indexed by door number, keyset, hardware heading number, cross keying instructions and special key stamping instructions.

F. Construction Key Distribution List: Submit upon Owner's request.

G. Templates: Furnish hardware templates to fabricators of doors, frames, and other work to be factory-prepared for hardware. Check shop drawings of other work, to confirm that adequate hardware backing is available.

H. Operations and maintenance data: At the completion of the job, provide to the Owner two copies of an Owner's operation and maintenance manual. The manual shall consist of a labeled hardcover three ring binder with the following technical information:

1. Title page containing: Project name, address and phone numbers. Supplier's name, address and phone numbers.

2. Table of Contents.

3. Copy of final Finish Hardware Schedule and Keying Schedule.

4. Maintenance instruction for each item of hardware.

5. Catalog pages for each product.

6. Installation Instructions and Parts List for all Locks, Exit Devices and Door Closers.

I. Project Record Documents: Include corrected hardware schedule.

J. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01325 – Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

3. Materials Resources Certificates:

4. Certify recycled material content for recycled content products.

K. CLOSEOUT SUBMITTALS

1. Section 01700 - Contract Closeout: Closeout procedures.

2. Project Record Documents: Record actual locations of installed cylinders and their master key code.

3. Operation and Maintenance Data: Submit data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

4. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

1.07 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements:

1. Provide hardware for fire resistive rated openings that complies with UL and listed by UL.

1.08 QUALITY ASSURANCE

A. Substitutions: Request for substitutions shall not be accepted within this project. Architect, Owner, and Hardware Consultant have selected 1 specified and 2 equals listed hereinafter in the Hardware Schedule. By this selection process they have established 3 equal products for competitive pricing, while insuring no unnecessary delays by a substitution process. If any specified product is listed as a "No Substitution" product, this product will be supplied as specified, with no alteration or request of substitution. The reason for this is to comply with the uniformity established at this project. Parts and supplies are inventoried for these particular products for ease and standardization of replacement.

B. Supplier Qualifications: Supplier shall be recognized architectural finish hardware supplier, with warehousing facilities, who have been furnishing hardware in the project vicinity for a period of not less than 2 years and who is or employs a DHI Certified AHC or person with a minimum of 10 years of experience as a hardware supplier. This person shall be available at reasonable times during the course of the work for consultation about products hardware requirements, to the Owner, architect, and CONTRACTOR.

C. Installer Qualifications (Mechanical Hardware): All finish hardware shall be installed by the finish hardware installer with a minimum of at least 2 years documented experience. Installer shall attend a pre-installation meeting between the contractor, finish hardware supplier, hardware manufacturers representative for locks, closers and exit devices, all door/frame suppliers. The

finish hardware installer shall be responsible for the proper installation and function of all doors and hardware.

D. Installer Qualifications (Electrified Hardware): All electrified finish hardware (power, load, switch, conductor and monitoring device) shall be installed by a Electronic Access Control installer licensed by the Texas Department of Public Safety. The electrified finish hardware installer shall have a minimum of at least 2 years of documented experience. Installer shall attend a pre-installation meeting between the contractor, finish hardware supplier, electrical contractor, fire alarm contractor, security contractor, hardware manufacturers representative for locks, closers and exit devices, all door/frame suppliers. The electrified finish hardware installer shall be responsible for the proper installation and function of all doors and hardware. Installation shall include wiring all electrified products (including the required wire to the power supply and/or junction box).

E. Regulatory Requirements:

1. Provide hardware for fire resistive rated openings that complies with UL and listed by UL.

1.09 PRE-INSTALLATION MEETINGS

A. Section 01200 – Project Meetings: Pre-installation meeting.

B. Keying Meeting:

1. Convene as soon after approval of product submittal as is feasible to ensure cores and keys are finalized before installation.

2. Required attendees: Owner, Architect, General Contractor, Hardware Supplier.

3. Pre-installation Conference:

4. Convene minimum one week prior to commencing work of this section.

5. Include persons involved with installation of doors, frames, and hardware.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Product storage and handling requirements.

B. Package hardware items individually with necessary fasteners, instructions, and installation templates, when necessary; label and identify each package with door opening code to match hardware schedule.

1.11 COORDINATION

A. Section 01310 – Schedules and Reports: Coordination and project conditions.

B. Coordinate Work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.

1. Provide templates or actual hardware as required to ensure proper preparation of doors and frames.

C. Sequence installation to accommodate required utility connections.

D. Coordinate Owner's keying requirements during course of Work.

1.12 WARRANTY

A. Section 01700 - Contract Closeout: Product warranties and product bonds.

B. Furnish minimum one year manufacturer warranty from the date of substantial completion for all hardware components specified in this section, unless noted otherwise this section. If manufacturer’s standard term of warranty exceeds this, provide manufacturer’s standard term. Coverage will include repair and replacement of all hardware at no charge to the Owner due to manufacturer defect or improper installation.

C. Furnish minimum ten year manufacturer warranty from the date of substantial completion for door closers specified in this section. If manufacturer’s standard term of warranty exceeds this, provide manufacturer’s standard term.

D. Furnish minimum five year manufacturer warranty from the date of substantial completion for panic hardware specified in this section. If manufacturer’s standard term of warranty exceeds this, provide manufacturer’s standard term.

1.13 MAINTENANCE MATERIALS

A. Section 01700 - Contract Closeout: Maintenance materials.

B. Furnish special wrenches and tools applicable for each different and for each special hardware component.

C. Furnish maintenance tools and accessories supplied by hardware component manufacturer.

1.14 EXTRA MATERIALS

A. Section 01700 - Contract Closeout: Spare parts and maintenance products.

B. Furnish ten extra key lock cylinders for each master keyed group.

1.15 SCHEDULING AND SEQUENCING

A. Upon receipt of accepted hardware schedule, coordinate accepted hardware schedule, templates, reinforcing units, and template instructions to door and frame sections.

B. Restrict distribution of construction keys to superintendents and foremen. Maintain record of persons who have received keys on construction distribution list.

PART 2 - PRODUCTS

2.01 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.02 DOOR HARDWARE

A. Manufacturers as follows:

Manufacturer	Abbrev	Website
Best Access	BES	www.bestaccess.com
Bommer Industries, Inc.	BOM	www.bommer.com
Falcon	FAL	www.falconlock.com

Glynn Johnson	GLY	www.glynn-johnson.com
Hager Hinge Company	HAG	www.hagerhinge.com
Ives	IVE	www.ives.ingersollrand.com
LCN	LCN	www.lcnclosers.com
National Guard	NGP	www.ngpinc.com
Rockwood	ROC	www.rockwoodmfg.com
Schlage	SCH	www.schlage.com
Trimco/BBW/Quality	TRI	www.trimcobbw.com
Von Duprin	VON	www.vonduprin.com
Zero	ZER	www.zerointernational.com

1. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

B. Hinges:

1. Manufacturers:

a. Hager.

b. Ives.

c. Bommer.

d. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2. Template: Provide templated units only.

a. Exterior: All exterior hinges shall be stainless steel base and finish.

b. Interior: All interior hinges stainless steel base and finish.

c. Exit devices: All hinges on doors with exit devices shall be heavy weight.

d. Electric Hinge: Provide 8 wire.

e. Provide non-removable pins for out-swinging doors that are locked or are lockable.

f. All hinges shall be ball bearing; concealed with interior self-lubricating bushings.

g. All hinges shall be five knuckle.

h. All hinges shall be full mortise.

i. Size: Provide 4-1/4 by 4-1/2 hinges on doors up to 3 feet 0 inches in width. Provide 5 by 4-1/4 hinges on door from 3 feet 2 inches to 4 feet 0 inches in width. Reference manufacturers catalog for all other sizes.

j. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges for door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.

k. The width of hinge shall be sufficient to clear all trim.

C. Mortise Locks

1. All locks on this project should be manufactured by the same manufacturer.

2. Mortise locksets shall meet ANSI/BHMA A156.13, Series 1000, Grade 1 Operational with all standard trims and conventional mortise cylinders.

3. All mortise locks shall be UL Listed for 3 hour fire door. Review lock for any height restriction.

4. Provide locks with a standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless steel.

5. Provide standard ASA strikes unless extended lip strike is necessary for frame/trim or 7/8” lip strike is necessary at pair with overlapping astragal.

6. Provide dust box.

7. Supply from the following list of manufacturers:

a. Schlage SCH

b. Falcon FAL

c. Best BES

D. Cylindrical Locks/Latches:

1. Supply from the following list of manufacturers:

a. Schlage SCH

b. Falcon FAL

c. Best BES

2. Provide cylindrical locksets that comply with ANSI A156.2, Series 4000, Grade 1; tested to exceed 3,000,000 cycles. Functions as listed in Hardware Sets.

3. Provide cylindrical locksets that meet ANSI A117.1, Accessibility Code.

4. Provide cylindrical locksets that meet UL A label; to have a minimum listing for single doors 4 feet by 8 feet.

5. Provide cylindrical locksets that comply with the Fire Safety Code; lever return to within 1/2 inch of the door where applicable.

6. Chassis to be one-piece, modular assembly.

7. Levers are to be solid. Manufacturers utilizing fillers of any kind are not acceptable.

8. Levers are to be plated to match BHMA finishes.

9. Levers to have grooved tactile warnings on back side of lever where shown in hardware sets. Manufactures that insert devices and/or apply materials for warning are not acceptable.

10. Thru-bolts to be a minimum of 1/4 inch in diameter.

11. Thru-bolts to secure anti-rotation plate without sheer line. Manufacturers utilizing fully threaded thru-bolts are not acceptable.

12. Adjustment plate to be threaded for door thickness adjustment.

13. Latchbolt to be steel with minimum 1/2 inch throw deadlatch on keyed and exterior functions; 3/4 inch throw anti-friction latchbolt on pairs of doors.

14. Strike to be ANSI curved lip, 1-1/4-inch by 4-7/8-inch, 16 gauge, with 1-inch deep box construction.

E. Exit Devices:

1. Supply from the following list of manufacturers:

   a. Falcon 24/25 Series.

   b. Von Duprin 33/99 Series.

2. All exit device types on this project should be manufactured by the same manufacturer.

3. Exit devices are to be architectural grade touch bar type. Mechanism case to be smooth.

4. Exit devices shall meet ANSI A156.3, 1994, Grade 1. All exit devices are UL listed for Accident Hazard or Fire Exit Hardware.

5. All lever trim to match lock trim in design and finish.

6. Dogging: All non-rated devices are to be provided with dogging. Cylinder dogging as shown in hardware sets.

7. Exit devices are to be supplied and installed with thru-bolts for all doors.

8. Mullion shall be removable. Keyed removable as shown in hardware sets.

9. Provide proper power supply for exit devices as required.

10. Exit devices shall have a flush end cap.

11. Exit devices shall be ordered with the correct strike for application.

12. Exit devices shall be order in the proper length to meet door width.

13. Exit devices shall have deadlatching.

14. Install exit devices with fasteners supplied by exit device manufacturer.

15. Provide glass bead kits as required.

16. Provide proper concealed vertical rods for wood or hollow metal doors as required.

F. Coordinator:

1. Supply from the following manufacturer:

a. Ives (COR).

b. Trimco.

c. Rockwood.

2. Provide coordinator that is a bar type.

3. UL listed for fire doors.

4. Provide filler bar as required for door width.

5. Provide all mounting brackets as required for installation of door closer, strikes, etc.

6. Meets ANSI/BHMA A156.3, Type 21A.

G. Door Closers:

1. Supply from the following list of manufacturers:

a. LCN 4010/4100.

b. Doromatic/Falcon.

c. Norton.

2. All door closers on this project should be manufactured by the same manufacturer.

3. Door closers shall meet the minimum requirements of the 1990 ADA act, in lieu of ANSI Standard A156.4 and ANSI, Grade 1 on interior fire rated openings.

4. Door closers shall be furnished with standard cover. Provide full cover as shown in hardware sets.

5. Size in accordance with the manufacturers recommendations for door size and condition.

6. Door closers shall be furnished with backcheck, delayed action, hold-open and advanced backcheck as listed in the Hardware Sets.

7. Provide and mount closer top jamb or on brackets and/or drop plates, where special conditions call for it.

8. All closer installation shall include thru bolts on all doors.

9. Door closers shall be cast iron.

10. Door closers shall be certified to exceed ten million full load operating cycles by a recognized independent testing laboratory.

11. Door closers shall be plated to match locks and exit devices.

12. Door closers shall be non-handed.

H. Door Stops and Holders:

1. Supply from the following list of manufacturers:

   a. Ives.

   b. Trimco.

2. Wall and Floor Stops: Supply wall stops where needed to protect doors or door hardware. When wall conditions do not permit use of wall stop provide floor stops with risers as needed to adjust for floor conditions.

3. Overhead Stops: Where wall or floors stops are not applicable provide surface overhead stops.

4. Exterior Stops: Provide security floor stop.

I. Silencers:

1. Supply from the following list of manufacturer's:

a. Ives (SR64/SR65).

b. Rockwood.

c. Trimco.

2. Provide silencers on all doors without seal. 3 for single doors and 2 for pairs.

3. Provide silencers as required for frame conditions.

J. Thresholds/Weatherstripping:

1. Supply from the following list of manufacturer's:

a. National Guard.

b. Zero.

2. All thresholds shall conform to state and local handicap codes.

3. Smoke seal shall be teardrop design bulb seal.

4. Exterior seal/thresholds shall be silicone or brush as shown in hardware sets.

5. Sound seal shall be neoprene.

6. Drip strips shall protrude 2-1/2 inches.

7. Provide door sweeps.

8. Provide UL meeting stile gasketing for fire rated doors.

2.03 KEYING

A. General:

1. Finish Hardware Supplier shall meet in person with Owner to finalize keying requirements and match existing or start a new Restricted and Patented Master Key System for the project.

B. Cylinders:

1. All cylinder/cores on this project should be manufactured and providing in the same keyway.

2. Provide the correct and quantity of cylinders for all applications.

C. Cores:

1. Provide cores with finger pins that provide a second shear line.

D. Keys:

1. Provide nickel silver keys only.

2. Furnish 2 change keys for each lock: 5 control keys: 5 master keys for each master system and 5 grandmaster keys for each grandmaster key system.

3. Emboss DO NOT DUPLICATE on keys.

4. Deliver all keys to Owner’s representative.

E. Cores and keys shall be provided with identification stamping.

F. Provide construction keying / construction cores for this project with constructions keys.

G. Key Control:

1. Key Management: Key control shall be provided, by supplying a complete key storage and management system.

a. Each key shall be fully cut, indexed, tagged and installed on cabinet hooks by the lock supplier and shipped with the locks.

b. Key cabinet provided shall be wall-mounted type with capacity plus 50 percent.

2.04 ACCESSORIES

A. Lock Trim: Furnish levers with rose plate as selected from manufacturer's full range of levers and roses.

1. Do not permit through bolts on solid wood core doors.

B. Through Bolts: Do not permit through bolts and grommet nuts on door faces in occupied areas unless no alternative is possible.

1. Do not use through bolts on solid wood core doors.

C. Key Cabinet:

1. Cabinet Construction: Sheet steel construction, piano hinged door with cylinder type lock master keyed to building system.

2. Cabinet Size: Size for Project keys plus sufficient room to allow for [10] [50] percent growth.

3. Horizontal strips for key hook labeling with clear plastic strip cover over labels.

4. Finish: Baked enamel finish, color as selected.

2.05 FINISHES

A. Butts:

1. Interior Non Labeled: Finish – 652.

2. Interior Labeled: Finish – 652.

3. Interior Corrosive Area: Finish – 630.

4. Exterior: Finish – 630.

5. Continuous Hinges: Finish – ALUM.

B. Flush Bolts/Dust Proof Strikes: Finish – 626.

C. Locks/Latches: Finish – 626.

D. Cylinders: Finish – 626.

E. Exit Devices: Finish – 630.

F. Door Closers: Finish – 626.

G. Push Plates: Finish – 630.

H. Pull Plates: Finish – 630.

I. Protective Plates: Finish – 630.

J. Door Stops and Holders: Finish – 626.

K. Overhead Stops/Holders: Finish – 626.

L. Weatherstrip and Threshold: Finish – ALUM.

Where indicated 630 finish, core metal shall be stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01310 – Scheduling and Reports: Coordination and project conditions.

B. Verify doors and frames are ready to receive door hardware and dimensions are as instructed by manufacturer.

C. Verify electric power is available to power operated devices and is of correct characteristics.

D. Examine doors, frames and related items for conditions that would prevent the proper application of any finish hardware items. Do not proceed with installation until all defects are corrected.

E. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Follow Door and Hardware Institute Publications:

1. Recommended Location for Architectural Hardware for Standard Steel Doors and Frames

2. Recommended Location for Builder's Hardware for Custom Steel Doors and Frames

3. Recommended Locations for Architectural Hardware for Wood Flush Door

B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

C. Follow ANSI A117.1-1998 Accessible and Usable Building and Facilities and Texas Accessibility Standards.

D. Coordinate mounting heights with door and frame manufacturers. Use templates provided by hardware item manufacturer.

E. Mounting Heights From Finished Floor to Center Line of Hardware Item: Comply with manufacturer recommendations and applicable codes where not otherwise indicated.

1. Locksets: 38 inch.

2. Push/Pulls: 42 inch.

3. Dead Locks: 48 inch.

4. Push Pad Type Exit Devices: 42 inch.

5. Cross Bar Type Exit Devices: 38 inch.

6. Top Hinge: Jamb manufacturer's standard, but not greater than 10 inches from head of frame to center line of hinge.

7. Bottom Hinge: Jamb manufacturer's standard, but not greater than 12-1/2 inches from floor to center line of hinge.

8. Intermediate Hinges: Equally spaced between top and bottom hinges and from each other.

9. Hinge Mortise on Door Leaf: 1/4 inch. to 5/16 inch from stop side of door.

3.03 FIELD QUALITY CONTROL

A. Section 01400 - Quality Control Services: Field inspecting, testing, adjusting, and balancing.

B. Architect's Architectural Hardware Consultant shall inspect installation and certify hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified. Contractor shall correct all items noted by inspector.

3.04 ADJUSTING

A. Section 01700 - Contract Closeout: Testing, adjusting, and balancing.

B. Check all hardware for adjustments and proper operation.

C. Adjust hardware for smooth operation.

D. Make adjustments and corrections as required by Architectural Hardware Consultant recommendation following inspection.

3.05 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01700 - Contract Closeout: Protecting installed construction.

B. Do not permit adjacent work to damage hardware or hardware finish.

C. The contractor shall use all means at his disposal to protect all finish hardware items from abuse, corrosion and other damage until the owner accepts the project as complete.

3.06 HARDWARE SCHEDULE

HARDWARE GROUP # 001

DC05-1002 DC05-1003 DC05-1004

Provide each opening with the following:

1	EA	MORTISE CYLINDER	20-061 ICX W/KEYED CONST. CORE (AS REQ)		626	SCH
1	EA	FSIC PERMANENT CORE	23-030 (AS REQ)		626	SCH
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	✓	BLK	SCE
		NOTE	BALANCE OF HARDWARE BY DOOR MFG.			

-COORDINATE HARDWARE REQUIREMENTS WITH DOOR MANUFACTURER PRIOR TO SUBMITTALS.
-REMOVE CYLINDER AND CORE IF NOT REQUIRED.

HARDWARE GROUP # C201.1

D05-1031

Provide each opening with the following:

2	EA	HINGE	5BB1 4.5 X 4.5		630	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8	✓	630	IVE
1	EA	EU MORTISE LOCK	L9092T EU 17A RX CON (FAIL SECURE)	✓	626	SCH
1	EA	FSIC PERMANENT CORE	23-030		626	SCH
1	EA	OVERHEAD HOLDER	100S		630	GLY
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ	✓		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS	✓		SCH
1	EA	CREDENTIAL READER	AS SPECIFIED IN DIVISION 28	✓		UNK
1	SET	GASKETING	328AA H & J		AA	ZER
1	EA	THRESHOLD	65A		A	ZER
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	✓	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)	✓	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HARDWARE GROUP # C205

D05-1005 D05-1011

Provide each opening with the following:

2	EA	HINGE	5BB1HW 4.5 X 4.5 NRP			630	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8		✓	630	IVE
1	EA	EU MORTISE LOCK	L9092T EU 17A RX CON (FAIL SECURE)		✓	626	SCH
1	EA	FSIC PERMANENT CORE	23-030			626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ			689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS			630	IVE
1	SET	GASKETING	328AA H & J			AA	ZER
1	EA	DOOR SWEEP	8198AA			AA	ZER
1	EA	THRESHOLD	65A			A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		✓		SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		✓		SCH
1	EA	CREDENTIAL READER	AS SPECIFIED IN DIVISION 28		✓		UNK
1	EA	DOOR CONTACT	679-05 TYPE AS REQ		✓	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)		✓	LGR	SCE

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HARDWARE GROUP # C714
D05-1021 D05-1022
Provide each opening with the following:

8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		630	IVE
2	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9947-DT-CON LENGTH & HEIGHT AS REQ		626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9947-L-CON LENGTH & HEIGHT AS REQ		626	VON
1	EA	RIM CYLINDER	20-057 ICX W/KEYED CONST. CORE		626	SCH
1	EA	FSIC PERMANENT CORE	23-030		626	SCH
2	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)		AA	ZER
1	SET	GASKETING	328AA H & J		AA	ZER
1	SET	MEETING STILE	8193AA (2 PCS - 1 SET)		AA	ZER
2	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	65A		A	ZER
2	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ			SCH
2	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS			SCH
1	EA	CREDENTIAL READER	AS SPECIFIED IN DIVISION 28			UNK
2	EA	DOOR CONTACT	679-05 TYPE AS REQ		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)			VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PADS.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HARDWARE GROUP # C715
D05-1001
Provide each opening with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-99-L-CON LENGTH AS REQ		626	VON
1	EA	RIM CYLINDER	20-057 ICX W/KEYED CONST. CORE		626	SCH
1	EA	FSIC PERMANENT CORE	23-030		626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	RAIN DRIP	142AA DW + 4" (OMIT @ COVERED OPENINGS)		AA	ZER
1	SET	GASKETING	328AA H & J		AA	ZER
1	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	65A		A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ			SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS			SCH
1	EA	CREDENTIAL READER	AS SPECIFIED IN DIVISION 28			UNK
1	EA	DOOR CONTACT	679-05 TYPE AS REQ		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)			VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PAD.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

HARDWARE GROUP # C715.1
D05-1006
Provide each opening with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-99-L-CON LENGTH AS REQ		626	VON
1	EA	RIM CYLINDER	20-057 ICX W/KEYED CONST. CORE		626	SCH
1	EA	FSIC PERMANENT CORE	23-030		626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	SET	GASKETING	328AA H & J		AA	ZER
1	EA	DOOR SWEEP	8198AA		AA	ZER
1	EA	THRESHOLD	65A		A	ZER
1	EA	WIRE HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ			SCH
1	EA	WIRE HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS			SCH
1	EA	CREDENTIAL READER	AS SPECIFIED IN DIVISION 28			UNK
1	EA	DOOR CONTACT	679-05 TYPE AS REQ		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC (OMIT 2RS BOARD WHERE NOT REQ)			VON

-INGRESS BY THE CREDENTIAL READER OR KEY OVERRIDE.
-FREE EGRESS BY THE PUSH PAD.
-COORDINATE POWER SUPPLY WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS.
-OMIT POWER SUPPLY WHERE PROVIDED BY SECURITY.

END OF SECTION 08710

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Glass glazing for doors and windows.

2. Glass glazing materials and installation requirements for other Sections that reference this Section.

3. Glazing accessories and sealants.

1.02 RELATED REQUIREMENTS

A. Section 07210 - Pre-Engineered Building Insulation: Materials and methods to create air seal in building enclosure and between adjacent materials or components.

B. Section 07900 - Joint Protection: Sealant and backup material other than glazing sealants.

C. Section 08110 – Steel Doors and Frames: Glazed doors.

D. Section 08410 – Metal Framed Storefronts: Aluminum and glass doors, door frames, and glazed lights for exterior and interior applications.

1.03 REFERENCE STANDARDS

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

B. American National Standards Institute (ANSI):

1. Z97.1 – Safety Performance Specifications and Methods of Test for Transparent Safety Glazing Materials Used in Buildings.

C. ASTM International (ASTM):

1. C 669 – Standard Specification for Glazing Compounds for Back Bedding and Face Glazing of Metal Sash.

2. C 1193 – Standard Guide for Use of Joint Sealants.

3. C 1036 – Standard Specification for Flat Glass.

4. C 1048 – Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.

5. E 330 – Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.

6. E 546 – Standard Test Method for Frost Point of Sealed Insulating Glass Units.

7. E 576 – Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.

8. E 773 – Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units.

9. E 1425 – Standard Practice for Determining the Acoustical Performance of Exterior Windows and Doors.

10. E 2190 – Standard Specification for Insulating Glass Unit Performance and Evaluation

D. Consumer Product Safety Commission (CPSC):

1. 16 CFR 1201 – Safety Standard for Architectural Glazing Materials.

E. Glass Association of North America (GANA):

1. GANA GM – Glazing Manual.

2. GANA – FGMA Sealant Manual.

3. GANA – Laminated Glass Design Guide.

F. Insulating Glass Certification Council (IGCC):

1. Certified Products Directory.

G. Underwriters Laboratories Inc.:

1. UL – Building Materials Directory.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data:

1. Glass: Submit structural, physical, thermal, solar, and optical performance characteristics, size limitations, and special handling or installation requirements.

2. Glazing Sealants, Compounds, and Accessories:

a. Submit chemical, functional, and environmental characteristics, limitations, and special application requirements.

3. Identify available colors where exposed. Submit color selector card for sealants to be exposed.

C. Shop Drawings: Indicate sizes, layout, thicknesses, and loading conditions for glass.

D. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for glass thicknesses.

E. Samples:

1. Glass, 1 square foot of each type specified.

2. Glazing sealants, 2-inch long beads, for color selection.

F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01325 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate:

   a. Certify that products meet or exceed specified sustainable design requirements.

   b. Materials Resources Certificates:

      1) Certify recycled material content for recycled content products.

   c. Indoor Air Quality Certificates: Certify VOC content for each interior adhesive, sealant, and related primer.

1.07 DESIGN AND PERFORMANCE CRITERIA

A. Performance Requirements:

1. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:

   a. In conjunction with materials described in Section 08410.

   b. To utilize inner pane of multiple pane sealed units for continuity of air barrier and vapor retarder seal.

   c. To maintain continuous air barrier and vapor retarder throughout glazed assembly from glass pane to heel bead of glazing sealant.

2. Size glass to withstand dead loads and positive and negative live loads acting normal to plane of glass as calculated in accordance with 2009 International Building Code and ANSI Z 97.1

3. Limit glass deflection to 1/200 or flexure limit of glass with full recovery of glazing materials, whichever is less.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years’ experience.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Texas.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum Conditions: Do not install glazing when ambient temperature is less than 50 deg. F.

C. Subsequent Conditions: Maintain minimum ambient temperature before, during, and 24 hours after installation of glazing compounds.

1.11 WARRANTY

A. Section 01700 - Contract Closeout Requirements for warranties.

B. Furnish ten-year manufacturer’s warranty for low-e coating for insulated glass.

C. Furnish five-year manufacturer's warranty for sealed-glass units' seal failure, interpane dusting or misting, and replacement.

PART 2 - PRODUCTS

2.01 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

C. Indoor Environmental Quality Characteristics:

1. Interior Adhesives: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

2. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

2.02 GLASS

A. Clear Tempered: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 or Class 2 as scheduled below, Quality q3; tempered without visible tong marks when installed; minimum 1/4 inch thick. Manufacturers: One of the following or equal:

1. Guardian Industries Corp., Auburn Hills, MI.

2. Vitro Architectural Glass (formerly PPG), Cheswick, PA.

B. Insulating glass units: IGCC Rating Level CBA when tested in accordance with ASTM E 773 and E 2190; hermetically sealed units consisting of minimum 1/4 inch thick, clear exterior light, minimum 1/4 inch thick, clear interior light, and 1/2 inch wide air space 90% Argon Fill, dehydrated with blended molecular sieve and silica gel desiccant, with metal spacer channel with bent corners and welded splice on one vertical side, and polyisobutylene primary and silicone secondary seals. Manufacturers: One of the following or equal:

1. Guardian Industries, Cor. Auburn Hills, MI.

a. Double Pane Insulating Glass:

1) Total Unit Thickness: 1 inch.

2) Product: SNX 62/27 Clear with coating Low-E #2; manufactured by Guardian.

3) Outer Pane:

a) Typical Glass Type: Clear Monolithic.

4) Air Space: Hermetic Air.

5) Inner Pane:

a) Typical Glass Type: Clear Monolithic.

6) U-Factor Winter Nighttime: 0.24 maximum.

7) Solar Heat Gain Coefficient: 0.27 maximum.

8) Visible Light Transmittance: 62% minimum.

9) Visible Light Reflectance (maximum):

a) Exterior: 11%.

b) Interior: 12%.

10) Light to Solar Gain Ratio: 2.31 minimum.

2. Vitro, Cheswick, PA

a. Solarban 70.

2.03 GLAZING MATERIALS

A. Setting blocks: Neoprene, 80 to 90 durometer.

B. Spacer blocks: 30 to 40 durometer, thickness equal or greater than insulated window thickness by minimum 6 inches long.

C. Pressure tape: Butyl rubber tape. Manufacturers: One of the following or equal:

1. Tremco Mfg. Co., Tremco 440 Tape.

2. 3-M Co., Weatherban 5422.

D. Sealant: Silicone. ASTM C920, Type S, Grade NS, Class A and Use suitable for glazing application indicated; single component; solvent curing; capable of water immersion without loss of properties; non-bleeding, non-staining, cured Shore A hardness of 15 to 25.

1. Product: Silicone Construction Sealant Series SCS-1200, manufactured by General Electric Co.

2. Color: As selected.

3. Structural Silicone: Furnish high-modulus structural silicone glazing materials where sealant bonds glass to substrate.

4. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

5. Manufacturers: One of the following or equal:

a. General Electric Co., Silicone Construction Sealant Series SCS-1200.

b. Dow Corning Corp., 999-A, Silicone Building and Glazing Sealant.

E. Glazing gaskets and other materials for exterior fenestration:

1. Aluminum storefronts: As specified in Section 08410.

2.04 SOURCE QUALITY CONTROL

A. Allowable bow and warp tolerances: As measured with glass resting on edge upon two 1 inch wide supports:

1. Typical: Maximum 1/8 inch in 48 inches.

2. Tempered glass: Maximum allowed by ASTM C 1048.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 - Contract Closeout: Requirements for installation examination.

B. Verify that openings for glazing are correctly sized and within acceptable tolerances.

C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions possibly impeding moisture movement, weeps are clear, and that surfaces are ready to receive glazing.

3.02 PREPARATION

A. Section 01700 - Contract Closeout: Requirements for installation preparation.

B. Clean contact surfaces with solvent and wipe dry.

C. Seal porous glazing channels or recesses with primer or sealer compatible with substrate.

D. Prime surfaces scheduled to receive sealant.

3.03 INSTALLATION OF MONOLITHIC GLASS

A. Conform to GANA Glazing Manual, manufacturer's instructions and accepted shop drawings by the Engineer.

B. Glaze doors in closed position after hanging and adjustment.

C. Accurately size and cut glass clean for each glazing condition. Do not nip edges.

D. Cut and set glass to full fit and play consistent with expansion and contraction requirements and at exterior for absolute security under maximum high velocity wind and vacuum stresses.

E. Maintain edge clearance at least equal to glass thickness from perimeter of glass to inside of rabbet.

F. Maintain 1/8-inch clearance between faces of glass and adjacent stop or bead.

G. Maintain minimum bite of 3/8 inch.

H. Set glass as required to ensure against optical distortion.

3.04 INSTALLATION OF INSULATED GLASS UNITS

A. Conform to GANA Glazing Manual, manufacturer's instructions and accepted shop drawings by the Engineer.

B. Use wet and dry glazing method.

C. Cut glazing tape to length and set against permanent stops to project 1/16 inch above sight line.

D. Place setting blocks at quarter points and no closer than 6 inches from corners.

E. Rest glazing on setting blocks and push against tape for full contact at perimeter of unit.

F. Place glazing gasket. Install removable stop with concealed leg notched to accommodate setting blocks. Align top of gasket with stops.

3.05 INSTALLATION OF GASKETS

A. Gaskets: Install in accordance with manufacturer's instructions.

B. Glazing of interior metal frames: Use pressure or foamed tape and sealant as indicated as required to eliminate rattle and reduce sound transmission.

3.06 SEALANT APPLICATION

A. Comply with applicable requirements of Section 08800, unless specifically noted otherwise.

B. Ensure protective coatings have been removed from aluminum surfaces.

C. Where setting blocks and spacer shims are required to be set in sealant, butter with sealant, place into position and allow to set prior to installation of glass.

D. Neatly tool sealant or compound joints to compress material and improve adhesion.

E. Repair or replace pockets exposed by tooling.

3.07 FIELD QUALTY CONTROL

A. Section 01400 - Quality Control Services: Requirements for inspecting and testing.

3.08 CLEANING

A. Section 01700 - Contract Closeout: Requirements for cleaning.

B. Remove glazing materials from finish surfaces.

C. Remove labels after Work is complete.

D. Clean glass and adjacent surfaces.

3.09 PROTECTION

A. Section 01700 - Contract Closeout: Requirements for protecting finished Work.

B. After installation, mark pane with an "X" by using removable plastic tape or paste.

3.10 GLASS AND LOCATION SCHEDULE

A. Exterior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:

1. Windows within 48 inches of doors: Insulating and tempered.

2. Windows in doors: Insulating and tempered.

B. Interior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:

1. Windows in doors: Insulating and tempered.

END OF SECTION 08800

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. A variety of stationary louvers.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):

1. 500-L - Laboratory Methods of Testing Louvers for Rating.

2. 500-D - Laboratory Methods of Testing Dampers for Rating.

3. 511 - Certified Ratings Program - Product Rating Manual for Air Control Devices.

B. ASTM International (ASTM):

1. D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.

C. Testing Application Standard (TAS):

1. 100A - Standard Test Procedure for Wind and Wind Driven Rain Resistance and/or Increased Windspeed Resistance of Soffit Ventilation Strip and Continuous or Intermittent Ventilation System Installed.

D. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

A. The words and terms listed below, are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.

1. Drainable-blade louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.04 SUBMITTALS

A. As specified in Section 15500 - Common Work Results for HVAC.

1.05 QUALITY ASSURANCE

A. Provide louvers with the following, unless otherwise specified:

1. AMCA certification and rating in accordance with AMCA 511 for air performance and water penetration.

PART II - PRODUCTS

2.01 GENERAL

A. Louver types: As indicated on the Drawings.

1. Identify louvers with a letter L followed by a number referring to a louver type in this Section.

2. Identify individual louver size and airflow rates.

B. Accessories:

1. Provide installation clips and flanged or jamb-mounting styles suitable for the mounting locations.

2. As indicated on the Drawings.

3. Provide extended sills for louvers indicated as installed recessed from the exterior wall surface.

4. Provide stainless steel fasteners unless noted otherwise.

5. Corrosion protection.

6. Provide gravity damper for outside air intake and exhaust louvers, unless noted otherwise.

C. Protective coatings for aluminum in contact with concrete or masonry:

1. Manufacturers: One of the following or equal:

a. Koppers Co., Inc.

b. Porter Coatings.

c. Tarmastic 100.

2.02 DESIGN AND PERFORMANCE REQUIREMENTS

A. Performance: In accordance with AMCA 511 when tested in accordance with AMCA 500.

B. Designed for 20 pounds per square foot wind load.

C. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

D. Louvers for severe windstorm applications:

1. Shall resist the cyclic pressures, static pressures, and missile impact loads in accordance with:

a. Applicable building codes as specified in Section 01410 - Regulatory Requirements.

2. Shall resist wind driven rain in accordance with:

a. TAS 100A:

1) Louvers shall not require the use of a manual damper to meet the certification requirements.

2.03 STATIONARY WEATHER LOUVERS

A. Manufacturers: One of the following or equal:

1. Greenheck ESD-603.

2. Airolite Co.

3. Ruskin.

B. Requirements:

1. Type: Stationary louver with drainable blades.

2. Frame: 6-inches deep, minimum 0.125-inch thick, Type 6063-T5 aluminum with downspouts and caulking channel provided.

3. Blades: Minimum 0.125-inch thick, Type 6063-T5 aluminum drainable blades spaced at 6-inch centers, stationary mounted at 37 degrees.

4. Screens: Removable aluminum frame with aluminum wire; insect screens on intakes and bird screens on exhausts.

5. Pressure drop (without screen): Maximum 0.15-inch water column for exhaust service and 0.15-inch water column for intake service at 1,000 feet per minute free area velocity.

6. Water penetration: Maximum 0.01-ounce water per square foot at 1,027 feet per minute free area velocity.

7. Mullions: Hidden.

8. Finish: Mill finish; color as selected.

C. Accessories:

1. Provide aluminum filter rack option.

PART III - EXECUTION

3.01 EXAMINATION

A. Inspect areas to receive louvers.

1. Notify the architect of conditions that would adversely affect the installation or subsequent utilization of the louvers.

2. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Clean opening thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install louvers at locations indicated on the Drawings and in accordance with manufacturer's instructions.

B. As specified in Section 15500 - Common Work Results for HVAC.

3.04 FIELD QUALITY CONTROL

A. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior Paperless Moisture Resistant Type X wall panels and joint treatment.

2. Paperless Gypsum Sheathing.

3. Metal stud wall framing.

1.02 RELATED REQUIREMENTS

A. Section 06100 - Rough Carpentry: Wood blocking for support.

B. Section 07213 - Batt Insulation: Acoustic and Thermal insulation.

C. Section 08110 – Steel Doors and Frames.

D. Section 09902 - Painting and Coating.

E. Section 13120 – Metal Building Systems: Support framing.

F. Division 15 – Mechanical Penetration.

G. Division 16 – Electrical Penetrations.

1.03 REFERENCE STANDARDS

A. American Society of Civil Engineers:

1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

B. ASTM International:

1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

2. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-formed Framing Members

3. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

4. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.

5. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.

6. ASTM C1002 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases.

7. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.

8. ASTM C1280 - Standard Specification for Application of Gypsum Sheathing.

9. ASTM C1288 - Standard Specification for Discrete Non-Asbestos Fiber-Cement Interior Substrate Sheets.

10. ASTM C1325 - Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cement Substrate Sheets.

11. ASTM C1396/C1396M - Standard Specification for Gypsum Board.

12. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.

13. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

14. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

15. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

16. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

17. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

C. California Department of Health Services:

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

D. Gypsum Association:

1. GA 214 - Recommended Levels of Gypsum Board Finish.

2. GA 216 - Application and Finishing of Gypsum Board.

3. GA-234 – Control Joints for Fire-Resistance Rated System.

4. GA 600 - Fire Resistance Design Manual Sound Control.

E. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

F. Metal Framing Manufacturer's Association (MFMA):

1. Guidelines for the Use of Metal Framing.

G. National Fire Protection Association:

1. NFPA 265 - Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Coverings on Full Height Panels and Walls, Method B.

2. NFPA 286 - Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Wall and Ceiling Interior Finish.

H. South Coast Air Quality Management District:

1. SCAQMD Rule 1168 - Adhesive and Sealant Applications.

I. Underwriters Laboratories Inc.:

1. UL - Fire Resistance Directory.

1.04 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit data on metal framing and trim accessories, gypsum board, backer boards, joint tape, joint and finish compounds.

C. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01325 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate:

a. Certify products meet or exceed specified sustainable design requirements.

b. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

c. Indoor Air Quality Certificates:

1) Certify volatile organic compound content for each interior adhesive and sealant and related primer.

2) Certify volatile organic compound content for each ceiling and wall system.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C754, GA-214, GA-216, and GA-600.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years’ experience.

B. Installer: Company specializing in performing Work of this section with minimum five years’ experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to manufacturer instructions.

1.08 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Maintain temperature at not less than 40 degrees F for the mechanical application of gypsum board unless otherwise recommended by manufacturer.

C. Maintain temperature at not less than 50 degrees F for the adhesive application of gypsum board, and for field finishing and texturing, unless otherwise recommended by manufacturer.

1.09 NOT USED

1.10 NOT USED

1.11 NOT USED

PART 2 - PRODUCTS

2.01 GYPSUM BOARD SYSTEMS

A. Manufacturers: One of the following or approved equal

1. CertainTeed.

2. Georgia-Pacific.

3. United States Gypsum.

4. Materials: Gypsum Interior Panels.

B. Interior Paperless Moisture Resistant Type X Gypsum Board: ASTM C630/C 1396; 5/8-inch thick, maximum available length in place; ends square cut and tapered.

1. CertainTeed Diamondback Glasroc Tile Backer Type X, ASTM C1396 and ASTM C1658; 5/8-inch thick, maximum available size in place; ends square cut and tapered.

2. Georgia Pacific, equivalent product.

3. USG, equivalent product.

C. Materials: Gypsum Sheathing Panels.

1. Exterior Water-resistant fiberglass faced Gypsum Sheathing Board: ASTM C1177/C 1396; 1/2-inch thick, maximum available length in place; ends square cut and tapered.

a. CertainTeed GlasRoc Sheathing, ASTM C1177 and ASTM C1396; 1/2-inch thick, maximum available size in place; ends square cut and tapered.

b. Georgia Pacific, equivalent product.

c. USG, equivalent product.

D. Accessories

1. For each type of wallboard material, use joint materials and accessories recommended by MANUFACTURER for that product.

2. Acoustic Insulation: ASTM C739; cellulose insulation, pneumatically placed.

3. Acoustic Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board; #808 Acoustical Sealants manufactured by Protective Treatments, or equal.

a. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

4. Uni-strut supports adequately sized where necessary between structural bar joist, beams, or trusses to support suspended gypsum board systems.

5. Corner Beads:

   a. External Corners – Metal; Dur -A-Bead No. 103 by USG, or equal.

   b. Internal Corners – Metal reinforced tape.

6. Edge Trim: GA-201 and GA-216; Type 200-A and 200-B by USG or equal.

7. Corner expansion joint: No. 30 Corner Expansion Joint by Cemco.

8. Drywall control joints: USG expansion joint type ASTM C1047 No. 093.

9. Joint Materials: GA-201 and GA-216; reinforcing tape, joint compound, adhesive, and water.

   a. Interior Adhesives: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

10. Powder Texture Product: USG Sheetrock Brand Wall and Ceiling Texture Tuf Tex.

11. Fasteners: ASTM C1002, Type S12 W and GA-216.

2.02 METAL STUD FRAMING

A. Manufacturers

1. Dietrich – Ultra steel

2. USG Building Systems.

3. National Gypsum Corporation.

4. Dale Incor.

5. Harrison Manufacturing.

6. Fire Trak deflection track and firestop system.

B. Materials

1. Framing System Components: ASTM C645.

2. Furring, Framing, and Accessories: ASTM A525, ASTM A591: non-load bearing rolled steel, channel-shaped, punched for utility access.

    a. 1/2 inch – 25 ga., standard duty.

    b. 7/8 inch – 25 ga., standard duty.

    c. 1 5/8 inch – 25 ga., standard duty.

    d. 2 inch – 25 ga., standard duty.

    e. 3 5/8 inch – 25 ga., standard duty

    f. 4 inch – 25 ga., standard duty.

    g. 6 inch – 22 ga., heavy duty.

    h. 8 inch – 25 ga., standard duty.

3. Door jambs and headers: 20 ga.

4. Storage & Closets with Wall attached shelf brackets: 20 ga.

5. Runners: Of same material and thickness of studs, bent leg retainer notched to receive studs.

6. Bracing Members: Of same materials as studs; thickness to suit purpose.

7. Fasteners: GA 203; Self-drilling, self-tapping screws.

8. Anchorage Devices: Type best suited to specific application.

9. Touch-up Primer for Galvanized Surfaces: Zinc rich coating, "ZRC."

10. Finish for Studs, Tracks, Headers and Accessories: Galvanize to G60 coating class.

11. Adhesive: Type best suited to specific application.

    a. Interior Adhesives: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

2.03 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

1. Materials and Resources Characteristics:

a. Recycled Content Materials: Furnish materials with maximum available recycled content.

2. Indoor Environmental Quality Characteristics:

a. Interior Adhesives: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

b. Interior Sealants and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 – Contract Closeout: Requirements for installation examination.

B. Verify site conditions are ready to receive work and opening dimensions are as instructed by manufacturer.

C. Verify that rough-in utilities are in place.

D. Verify that opening dimensions are as indicated on Shop Drawings and/or instructed by manufacturer.

3.02 ERECTION – METAL STUD FRAMING SYSTEM

A. Plumb and secure top and bottom runners at locations indicated on plan. Place two beads of acoustical sealant between runners and substrate to achieve an acoustic seal.

B. Extend stud framing to above ceiling. Attach ceiling runner securely to framing in accordance with Manufacturer's instructions and as indicated per drawings.

C. Refer to Drawings for indication of partitions extending stud framing through the ceiling to the structure above. Maintain clearance under structural building members to avoid deflection transfer to studs. Provide extended leg ceiling runners.

D. Install studs vertically at 16 inches on center unless otherwise directed.

E. Align stud web openings horizontally.

F. Secure studs to tracks using fastener method. Do not weld.

G. Stud splicings are not permissible.

H. Fabricate corners using a minimum of three studs.

I. Install double studs at wall openings, door, and window frame jambs not more than two inches from each side openings.

J. Brace stud framing systems rigid.

K. Coordinate erection of studs with requirements of door frames, window frames and blocking for surface mounted items. Install supports and attachments.

L. Coordinate installation of wood bucks, anchors, and wood blocking with electrical and mechanical work to be placed within or behind stud framing.

M. Blocking: Secure wood blocking to studs. Secure steel channels to studs. Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, multimedia boards, tack boards and signage.

N. Coordinate placement of insulation in stud spaces made inaccessible after stud framing erection.

3.03 INTERIOR GYPSUM BOARD INSTALLATION

A. Install all gypsum board materials in accordance with GA-201, GA-216 and GA-600 and in strict accordance with Manufacturer's instructions.

B. Erect single layer gypsum board vertically, with edges and ends occurring over firm bearing.

C. Erect exterior gypsum sheathing horizontally, with edges butted tight and ends occurring over firm bearing.

D. Use screws when fastening gypsum board to metal furring or framing.

E. Treat cut edges and holes in moisture resistant gypsum board with sealant.

F. Place control joints consistent with lines of building. Space at maximum of 30 feet both horizontally and vertically, and as shown on drawings.

G. Place corner beads at external corners. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials.

H. Install corner expansion joints at all conditions where drywall meets exterior walls.

I. Install backing board over metal studs in accordance with Manufacturer's instructions.

3.04 GYPSUM SHEATHING INSTALLATION

A. Install in accordance with manufacturer recommendations and ASTM C1280 and GA-253.

1. Fasten panels to cold formed metal framing with screws.

a. Cut sheathing panels at penetrations, edges, and other obstructions of work to allow for application of air-barrier accessory materials. Fit sheathing panels closely against abutting construction.

B. Install sheathing panels with long dimension perpendicular or parallel to framing. Abut ends and edges of panels centered over face of framing members. Offset panel joints by not less than one stud spacing.

1. Apply sheathing panels in pieces sized to provide minimum number of joints and optimum sheathing board arrangement. Arrange joints so that panels do not span between fewer than three support members.

2. Do not bridge building expansion joints; cut and space edges of factory fluid-applied air and water barrier panels to match spacing of structural support elements.

C. Fasteners:

1. Spacing:

a. Space fasteners maximum 8 inches (203 mm) o.c. in the field of the panel.

b. Set back a minimum of 3/8 inch (9.5 mm) from edges and ends panels and

2. Apply fasteners so heads are seated flush to the board product surface without breaking or punching through the surface.

a. Treat all sheathing fasteners specified fluid-applied flashing used for sealing joints.

3. Use fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections.

D. Apply Gypsum Sheathing and Type X Gypsum Sheathing horizontally to metal framing

E. Stagger end joints on horizontal applications.

3.05 JOINT TREATMENT

A. All joints and interior angles shall have tape embedded in joint compound and three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories.

B. A thin skim coat of joint compound, or a material manufactured especially for this purpose, shall be applied to the entire gypsum board surface to achieve smooth finish.

C. Finish surfaces of fur-downs and ceilings shall be smooth and free of tool marks and ridges.

D. Fill and finish joints and corners of backing board.

E. All other gypsum wall and ceiling finishes shall be smooth.

F. All inside corner gypsum assemblies at exterior wall are to use corner expansion joints.

3.06 TOLERANCES

A. Section 01400 - Quality Control Services: Tolerances.

B. Maximum Variation of Finished Gypsum Board Surface from Flat Surface: 1/8 inch in 10 feet in any direction.

3.07 PROTECTION

A. Section 01700 – Contract Closeout: Requirements for protecting finished Work.

B. Protect gypsum board installations and finish from damage and deterioration until date of Substantial Completion.

3.08 SCHEDULE

A. Install paperless interior gypsum board:

1. On interior face of interior partitions in conditioned spaces.

2. On both faces of partition between 05-101 and 05-102.

3. On interior face of exterior wall in Room 05-101.

B. Install gypsum sheathing:

1. On non-conditioned face of interior partitions.

C. Reference Drawings for more information.

END OF SECTION 09260

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Acoustical panels.

2. Suspended metal grid ceiling system and perimeter trim.

3. Supplementary acoustic insulation over system units.

1.02 RELATED REQUIREMENTS

A. Section 07213 - Batt Insulation: Acoustic batt insulation.

B. Section 07900 - Joint Sealers: Acoustic sealant for perimeter moldings.

C. Section 09260 – Gypsum Board Assemblies: Adjacent wall substrates.

D. Section 09902 - Painting: Touchup painting of acoustical units.

E. Section 13120 – Metal Building Systems: Support framing.

F. Section 15500 – Common Work Results for HVAC: Air diffusion devices in ceiling system.

G. Section 16510 - Lighting: Light fixtures in ceiling system.

1.03 REFERENCE STANDARDS

A. American Society of Civil Engineers:

1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

B. ASTM International:

1. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

2. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

3. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

4. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

5. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

6. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.

7. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.

C. Ceilings & Interior Systems Construction Association:

1. CISCA - Acoustical Ceilings Use & Practice.

D. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

E. NFPA:

1. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

F. UL:

1. UL - Fire Resistance Directory.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit manufacturer information regarding metal grid system components, and acoustic units.

C. Samples: Include two nominal 12 x 12 inch in size illustrating material and finish of acoustic units.; two samples each, 12 inches long, of suspension system main runner, cross runner, edge trim, and clips.

D. Manufacturer's Installation instructions.

E. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

b. Indoor Air Quality Certificates:

1) Certify volatile organic compound content for each interior paint and coating.

2) Certify volatile organic compound content for each ceiling and wall system.

F. MAINTENANCE MATERIAL SUBMITTALS

1. Section 01700 – Contract Closeout: Requirements for maintenance materials.

2. Extra Stock Materials:

a. Furnish 48sq. ft. of extra panels to Owner.

1.07 SEQUENCING

A. Section 01010 – Summary of Work: Requirements for sequencing.

B. Sequence Work of this Section to ensure that acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating

activities have terminated, and overhead Work has been completed, tested, and approved.

C. Install acoustic units after interior wet-work has dried.

1.08 QUALITY ASSURANCE

A. Comply with CISCA requirements.

B. Surface-Burning Characteristics:

1. Maximum Flame-Spread/Smoke-Developed Index: 200/450.

2. Testing: Comply with ASTM E84.

1.09 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum and Subsequent Conditions: Maintain uniform minimum temperature of 60 degrees F and maximum relative humidity of 40 percent prior to, during, and after acoustic unit installation.

PART 2 - PRODUCTS

2.01 LAY-IN ACOUSTICAL PANELS

A. Manufacturers: One of the following or equal:

1. Armstrong World Industries, Inc; Cirrus 589HRC as basis of design.
2. USG Interiors; Millennia ClimaPlus FLB
3. CetainTeed, Cashmere CM-450

B. Type: FS SS-S-118, Class 25, with following characteristics:

1. Material: Fire-retardant mineral board.
2. Style: Cirrus.
3. Face Size: 24 by 24 inches.
4. Thickness: 3/4 inch.
5. Edges: Beveled Tegular.
6. Finish: Factory-applied latex paint; white.
7. NRC Range: 0.70 for Number 7 mounting.
8. CAC: 35.
9. Articulation Class: 170.
10. Light Reflectance: 85 percent.
11. Recycled content: highest available from manufacturer.

2.02 SUSPENDED ACOUSTICAL CEILING GRID

A. Manufacturers: One of the following or equal:

1. Armstrong World Industries, Inc; Suprafine XL 9/16” Exposed Tee System

2. USG Interiors; Donn Contricitee DXT/DXLT

3. CetainTeed, 9/16” Grid

B. Grid conforming to the following:

1. Non-fire Rated Grid: ASTM C635, exposed T; components die cut and interlocking.

2. Grid Materials: Hot dipped galvanized steel.

3. Exposed Grid Surface Width: 9/16 inch.

4. Grid Finish: White.

5. Accessories: Stabilizer bars, clips, splices, perimeter moldings, and hold down clips required for suspended grid system.

6. Support Channels and Hangers: Galvanized steel; size and type to suit application, and ceiling system flatness requirement specified.

7. Recycled content: highest available from manufacturer.

2.03 ACCESSORIES

A. Escutcheons: Metal with thickness and finish to match ceiling grid.

B. Touch-up Paint: Type and color to match acoustic and grid units.

1. Interior Flat and Non-Flat Paints: Maximum volatile organic compound content in accordance with GS-11.

C. Hanger Wire: Galvanized carbon steel, soft temper, pre-stretched, yield stress load at least three times design load but not less than 12 gauge.

2.04 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01700 – Contract Closeout: Requirements for installation examination.

B. Verify that layout of hangers will not interfere with other Work.

3.02 PREPARATION

A. Broom clean area and remove obstructions for free movement of scaffolding.

B. Protect floor surfaces from damage by scaffolding.

3.03 INSTALLATION

A. Lay-In Grid Suspension System:

1. Install suspension system in accordance with ASTM C636 and as supplemented in this section.

2. Install system capable of supporting imposed loads to deflection of 1/360 maximum.

3. Locate system on room axis according to reflected plan.

4. Install after major above ceiling work is complete. Coordinate location of hangers with other work.

5. Install hanger clips during steel deck erection. Install additional hangers and inserts as required.

6. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

7. Where ducts or other equipment prevent regular spacing of hangers, reinforce nearest affected hangers and related carrying channels to span extra distance.

8. Do not support components on main runners or cross runners when weight causes total dead load to exceed deflection capability. Support

fixture loads by supplementary hangers located within 6 inches of each corner; or support components independently.

9. Do not eccentrically load system, or produce rotation of runners.

10. Perimeter Molding:

    a. Fasten trim to framing with fasteners at spacing as recommended by trim manufacturer

    b. Install trim true and flush with adjacent surfaces.

    c. Install splice plates at joints in trim to maintain alignment and produce a hairline joint.

B. Lay-In Acoustical Ceiling Panels:

1. Neatly cut panels to fit spaces so panel edges are supported by suspension system.

2. Install lay-in panels level, in uniform plane without twists, warps, or dents.

3. Leave no visible gaps or openings. Discard panels with cracks or chipped edges.

4. Leave no scrap above ceiling.

5. Install panels with apparent grain running in same direction.

6. Install escutcheons around openings for pipes, supports, and ducts through ceiling.

7. Install hold-down clips on panels within 20 feet of exterior doors.

C. Install batt insulation above panels per Section 07213.

3.04 TOLERANCES

A. Section 01400 - Quality Control Services: Requirements for tolerances.

B. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

C. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.05 CLEANING

A. Clean dirty and discolored exposed surfaces of panels in accordance with manufacturer's instructions.

B. Remove damaged panels that cannot be properly cleaned and replace with acceptable panels.

3.06 SCHEDULES

A. Room 05-101 Sample Station.

END OF SECTION 09511

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PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Resilient tile flooring

2. Resilient base.

1.02 RELATED REQUIREMENTS

A. Section 410S – Concrete Structures.

B. Section 09260 – Gypsum Board Assemblies: Substrate for wall base.

1.03 REFERENCES

A. ASTM International:

1. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

2. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile.

3. ASTM F1861 - Standard Specification for Resilient Wall Base.

B. California Department of Health Services:

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

C. Federal Specification Unit:

1. FS L-F-475 - Floor Covering Vinyl, Surface (Tile and Roll), with Backing.

2. FS RR-T-650 - Treads, Metallic and Nonmetallic, Skid Resistant.

D. National Fire Protection Association:

1. NFPA 253 - Standard Method of Test for Critical Radiant Flux for Floor Covering Systems Using a Radiant Heat Energy Source.

E. Scientific Certification Systems:

1. SCS EC10.2 - Environmental Certification Program Indoor Air Quality Performance.

F. South Coast Air Quality Management District:

1. SCAQMD Rule 1168 - Adhesive and Sealant Applications.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Submittal procedures.

B. Product Data: Submit data describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

C. Samples: Submit manufacturer's complete set of color samples for initial selection.

D. Submit two samples, 2 by 2 inch in size, illustrating color and pattern for each resilient flooring product specified.

E. Installation Instructions: Submit manufacturer’s installation instructions.

F. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

b. Indoor Air Quality Certificates:

1) Certify volatile organic compound content for each interior adhesive and sealant and related primer.

2) Certify volatile organic compound content for each flooring system.

G. CLOSEOUT SUBMITTALS

1. Section 01700 – Contract Closeout: Closeout procedures.

2. Operation and Maintenance Data: Submit maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

H. MAINTENANCE MATERIAL SUBMITTALS

1. Section 01700 – Contract Closeout: Spare parts and maintenance products.

2. Furnish 25 sq ft of flooring for each 625 sq ft installed or fraction thereof, 25 lineal feet of base or 5 percent of amount installed, whichever is greater, of each type and color specified.

1.07 QUALITY ASSURANCE

A. Surface Burning Characteristics:

1. Floor Finishes and Stair Coverings: Class I, minimum 0.45 watts/sq cm when tested in accordance with NFPA 253.

2. Base Material: Class I, minimum 0.45 watts/sq cm when tested in accordance with NFPA 253.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this section with minimum three years' experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Product storage and handling requirements.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Maintain temperature in storage area between 55 degrees F and 90 degrees F.

C. Store materials for not less than 48 hours prior to installation in area of installation at temperature of 70 degrees F to achieve temperature stability.

D. Subsequent Conditions: Thereafter, maintain conditions above 55 degrees F.

1.11 WARRANTY

A. Section 01700 – Contract Closeout: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for resilient flooring.

PART 2 - PRODUCTS

2.01 TILE FLOORING

A. Vinyl Composition Tile: ASTM F1066:

1. Manufacturers and products:

a. Armstrong; Standard Excelon Imperial Texture as basis of design.

b. Congoleum Corp.

c. Tarkett-Azrock.

d. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

2. Size: 12 x 12 inch.

3. Thickness: 0.125 inch.

4. Pattern: ASTM F1066 Class Marbleized.

5. Color: As selected.

2.02 RESILIENT BASE

A. Manufacturers:

1. Burke; Premium TS Molded Wall Base

2. Johnsonite; Baseworks Thermoset Rubber Wallbase.

3. Roppe; Pinnacle.

4. Substitutions: As specified in section 01600 – Products, Materials, Equipment, and Substitutions.

B. Base: ASTM F1861 Type TS - Vulcanized, Group 1 – Solid, Style B cove:

1. Height: 4 inch.

2. Thickness: 0.125 inch thick.

3. Finish: Satin.

4. Length: Roll.

5. Accessories: Premolded external corners, internal corners, and end stops. Same material, size, and color of base.

6. Color: As selected.

2.03 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

C. Indoor Environmental Quality Characteristics:

1. Interior Adhesives: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

2. Interior Hard Surface Flooring: FloorScore Certified for VOC content in accordance with SCS EC10.2.

2.04 ACCESSORIES

A. Subfloor Filler: Cementitious; type recommended by adhesive material manufacturer.

B. Primers and Adhesives: Waterproof; types recommended by flooring manufacturer.

C. Sealer and Wax: Types recommended by flooring manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01310 – Schedules and Reports: Verification of existing conditions before starting work.

B. Verify that surfaces are smooth and flat with a maximum variation of 1/8 inch in 10 ft. and are ready to receive work.

C. Verify concrete floors are dry to maximum moisture content as recommended by manufacturer, and exhibit negative alkalinity, carbonization, and dusting.

D. Verify floor and lower wall surfaces are free of substances capable of impairing adhesion of new adhesive and finish materials.

3.02 PREPARATION

A. Section 01700 – Contract Closeout: Requirements for installation preparation.

B. Remove sub-floor ridges and bumps.

C. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.

D. Prohibit traffic until filler is cured.

E. Vacuum clean substrate.

F. Apply primer as recommended by manufacturer or required to prevent "bleed-thru" or interference with adhesion by substances cannot be removed.

G. Where floor finishes are different on opposite sides of door, terminate flooring under centerline of door.

H. Coved Base:

1. Install coved base as detailed on drawings.

I. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

J. Access Covers:

1. Install flooring in recessed floor access covers.

2. Maintain floor pattern.

K. At movable partitions, install flooring under partitions without interrupting floor pattern.

L. Install feature strips and floor markings where indicated. Fit joints tightly.

3.03 INSTALLATION - TILE FLOORING

A. Install in accordance with manufacturer’s instructions.

B. Mix tile from container to ensure shade variations are consistent when tile is placed.

C. Spread only enough adhesive to permit installation of materials before initial set.

D. Set flooring in place pressing with heavy roller (100 pounds} to attain full adhesion.

E. Lay flooring with joints and seams parallel to building lines to produce symmetrical tile pattern.

F. Pattern:

1. Install tile to basket weave pattern.

2. Allow minimum 1/2 full size tile width at room or area perimeter.

G. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

H. Where floor finishes are different on opposite sides of door, terminate flooring under centerline of door.

I. Access Covers:

1. Install flooring in recessed floor access covers.

2. Maintain floor pattern.

3.04 INSTALLATION - BASE

A. Fitting:

1. Fit joints tightly and make vertical.

2. Maintain minimum dimension of 18 inches between joints.

B. Corners:

1. At external corners, use premolded units**.** At exposed ends, use premolded units.

C. Attachment:

1. Install base on solid backing.

2. Bond tightly to wall and floor surfaces.

D. Scribe and fit to door frames and other interruptions.

3.05 CLEANING

A. Section 01700 – Contract Closeout: Final cleaning.

B. Remove excess adhesive from floor, base, and wall surfaces without damage.

C. Clean, seal, and maintain resilient flooring products.

3.06 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01700 – Contract Closeout: Protecting installed construction.

B. Prohibit traffic on resilient flooring for 48 hours after installation.

3.07 ATTACHMENTS

A. Refer to Contract Drawings and to Room Finish Schedule for locations of specified materials.

END OF SECTION 09650

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Surface preparation and field application of paints, and other coatings.

1.02 RELATED REQUIREMENTS

A. Section 08110 – Steel Doors and Frames: Shop primed steel frames to be painted.

B. Section 09260 – Gypsum Board Assemblies: Wall, partition, and ceiling substrates for painting.

C. Section 13120 – Metal Building Systems: Metal frames exposed and painted.

D. Section 15005 – Piping Identification: Stenciling, color-coding, and identification banding.

E. Section 16011 - Identifications: Stenciling, color-coding, and identification banding.

1.03 REFERENCE

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

B. Steel Structures Painting Council (SSPC):

1. SSPC SP-1 - Surface Preparation Specification No. 1 - Solvent Cleaning.

2. SSPC SP-2 - Surface Preparation Specification No. 2 - Hand Tool Cleaning.

3. SSPC SP-3 - Surface Preparation Specification No. 3 - Power Tool Cleaning.

4. SSPC SP-5 - Surface Preparation Specification No. 5 - White Metal Blast Cleaning.

5. SSPC SP-6 - Surface Preparation Specification No. 6 - Commercial Blast Cleaning.

6. SSPC SP-7 - Surface Preparation Specification No. 7 - Brush-Off Blast Cleaning.

7. SSPC SP-8 - Surface Preparation Specification No. 8 - Pickling.

8. SSPC SP-10 - Surface Preparation Specification No. 10 - Near-White Blast Cleaning.

C. National Association of Corrosion Engineers (NACE):

1. NACE No. 1 - White Metal Blast Cleaning.

2. NACE No. 2 - Near-White Blast Cleaning.

3. NACE No. 3 - Commercial Blast Cleaning.

4. NACE No. 4 - Brush-Off Blast Cleaning.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Submit the following in accordance with Specification Section 01300 - Submittals.

1. Painting Schedule: Submit list indicating major items to be painted, preparation, paint manufacturer, product designation, and dry mil thickness.

2. Panels

a. Submit panels containing samples of proposed paints and coatings. Include three displays of each kind and color of paint used. Panel to be representative of material to be coated.

b. Mark panels to indicate respective types of surfaces to which several kinds and colors of paint, stain, and coating are applied.

3. Samples: If requested by Owner, submit 1/4 pint of each kind of paint or stain proposed for use. Do not deliver materials to site until representative samples (if requested) have been approved.

4. For all materials, furnish Engineer with two sets of manufacturer's printed instructions describing surface preparation procedures and application procedures including environmental limits (temperature and humidity).

5. Material Safety Data Sheets (MSDS) for all coatings, solvents, sealers, and paints to be utilized.

B. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify that following products meet or exceed specified sustainable design requirements:

    a. Indoor Air Quality Certificates:

        1) Certify VOC content for each interior paint and coating.

        2) Certify VOC content for each flooring system.

C. CLOSEOUT SUBMITTALS

1. Section 01700 – Contract Closeout: Requirements for submittals.

2. Operation and Maintenance Data: Submit information on cleaning, touchup, and repair of painted and coated surfaces.

D. MAINTENANCE MATERIAL SUBMITTALS

1. Section 01700 – Contract Closeout: Requirements for maintenance materials.

2. Extra Stock Materials:

    a. Furnish 1 gal. of each color, as provided for Project.

    b. Label each container with manufacturer's label, color, type, texture.

    c. Store where directed by Owner.

1.07 DEFINITIONS

A. Refer to ASTM D16 for definitions of terms used in this Section.

1.08 SYSTEM DESCRIPTION

A. Surfaces receiving coatings include:

1. Equipment, machinery, and metal surfaces.

2. Interior surfaces, as noted in room finish schedule.

3. Concrete surfaces, including concrete blocks (when noted on PLANS).

4. All cabinet and woodwork. (Stain finish unless otherwise noted.)

5. Paint concealed structural steel and steel joists, after erection of deck and before steel is enclosed.

6. Procedures and coating systems specified herein are in addition to shop priming and surface treatment specified in other technical Specification Sections.

B. Unless otherwise noted or shown, the following areas or items do not require coating:

1. Non-ferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, stainless steel, chromium plate, and atmospherically exposed weathering steel, except where:

a. Required for electrical insulation between dissimilar metals;

b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry;

c. Color coding of equipment and piping is required.

2. Non-metallic materials such as glass, PVC, porcelain, and fiberglass, except as required for architectural painting or color coding.

3. Pre-finished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches, panelboards, acoustical tile, cabinets, elevators, building louvers, etc., except when color coding of equipment is required.

4. Non-submerged electrical conduits attached to unpainted concrete surfaces.

5. Items specified to be galvanized after fabrication unless specified elsewhere or subject to immersion.

6. Insulated piping except as required for architectural painting or color coding.

1.09 SEQUENCING

A. Section 01010 – Summary of Work: Requirements for sequencing.

B. Do not apply finish coats until paintable sealant is applied.

C. Back prime wood trim before installation of trim.

1.10 QUALITY ASSURANCE

A. Manufacturer: All paints, sealers, and coatings to be manufactured by those firms listed in Table 2. Products of equal quality by other manufacturers will be considered, subject

to review of written submittal that includes product data and a detailed paint and coating schedule.

B. Workmanship:

1. Furnish workers who perform quality work and who are experienced and knowledgeable in the surface preparation and application of coatings. Submit list of five similar projects which have been prepared and coated by the personnel which the Contractor proposes to employ for this project.

2. Submit manufacturer's written instructions on cleaning and coating prior to any surface preparation or coating.

C. Whenever possible, all coatings should be from single manufacturer. Unless otherwise specified, coating materials for a specific surface or piece of equipment are to be from a single manufacturer.

D. All coatings provided for use on this project in the field or from equipment suppliers will be in compliance with Federal, State, and local laws, regulations and ordinances related to items such as lead, chromate, carcinogens and volatile organic compounds.

1.11 QUALIFICATIONS

A. Manufacturer: All paints, sealers, and coatings to be manufactured by those firms listed in Table 2. Products of equal quality by other manufacturers will be considered, subject to review of written submittal that includes product data and a detailed paint and coating schedule.

B. Workmanship:

1. Furnish workers who perform quality work and who are experienced and knowledgeable in the surface preparation and application of coatings. Submit list of five similar projects which have been prepared and coated by the personnel which the Contractor proposes to employ for this project.

2. Submit manufacturer's written instructions on cleaning and coating prior to any surface preparation or coating.

C. Whenever possible, all coatings should be from single manufacturer. Unless otherwise specified, coating materials for a specific surface or piece of equipment are to be from a single manufacturer.

D. All coatings provided for use on this project in the field or from equipment suppliers will be in compliance with Federal, State, and local laws, regulations and ordinances related to items such as lead, chromate, carcinogens and volatile organic compounds.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

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

C. Inspection:

1. Accept materials on Site in manufacturer's sealed and labeled containers.

2. Inspect for damage and to verify acceptability.

D. Store materials in ventilated area and otherwise according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to manufacturer instructions.

1.13 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Storage Conditions:

1. Minimum Ambient Temperature: 45 degrees F.

2. Maximum Ambient Temperature: 90 degrees F

C. Application Conditions:

1. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint manufacturer.

2. Do not apply exterior coatings during rain or snow, when relative humidity is outside humidity ranges, or when moisture content of surfaces exceeds those required by paint manufacturer.

3. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors and 50 degrees F for exteriors, unless otherwise indicated by manufacturer instructions.

4. Lighting Level: 80 fcmeasured mid-height at substrate surface.

PART 2 - PRODUCTS

2.01 PAINTS AND COATINGS

A. Manufacturers:

1. Coating manufacturers are listed by generic type and service in Table 2 attached to this Section.

2.02 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements specifies requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

C. Indoor Environmental Quality Characteristics:

1. Interior Flat and Non-Flat Paints: Maximum volatile organic compound content in accordance with GS-11.

2. Interior Anti-Corrosive Paints: Maximum volatile organic compound content in accordance with GC-03.

3. Interior Clear Wood Finishes, Floor Coatings, Stains, Primers, and Shellacs: Maximum volatile organic compound content in accordance with SCAQMD Rule 1113.

4. Interior Concrete, Wood, Bamboo, and Cork Floor Finishes: Maximum volatile organic compound content in accordance with SCAQMD Rule 1113, including sealers and stains.

2.03 MATERIALS

A. Tables 1 and 2 in this Section include the paint, protective coatings, and sealers for this project. Furnish all such special materials required for the manufacturer’s coating systems whether or not included in the Tables.

B. Products to comply with Federal, State, and local requirements limiting the emission of volatile organic compounds. The maximum volatile organic content of the combination of coating and thinner is not to exceed the following limits (whichever is less):

1. 0.41 pounds per gallon; or 50 grams per liter (for interior applications)

2. The Federal, State or local limit.

C. Colors:

1. Owner reserves the right to select colors.

2. Submit list of items to be painted and color charts for each type of surface.

3. Formulate with colorants free of lead or lead compounds.

D. Safety Color Codes: Follow OSHA requirements of 29 CFR, Part 1910.144 for "Safety Color Codes for Marking Physical Hazards." The following general requirements are set forth as a guide.

1. Red: Fire protection equipment, danger signs, and fire exit signs.

2. Orange: Moving or rotating parts of equipment protected by guards, including shafts and couplings, pulleys, and sprockets. (Do not paint wearing surfaces.)

3. Yellow: Caution signs and all physical hazards, including platforms, bollards and walls subject to being struck.

PART 3 - EXECUTION

3.01 GENERAL

A. Use one convenient location for storing and mixing of materials and keep fire extinguisher available in this area as long as location is used for such purpose.

B. Thinners and Solvents: Use only those thinners and solvents specified in paint formulas of paint being used and mix in proportions recommended by paint manufacturer.

C. Coverage: As recommended by paint manufacturer and sufficient to obtain minimum mil thickness specified. Do not exceed maximum thickness specified by manufacturer, if applicable. After final coat is applied, check with elecometer or Mikrotest dry film thickness gauge.

D. Drying Time: Between successive coats, allow drying time as specified by paint manufacturer. Do not apply additional coats until previous coat is completed.

E. Provide adequate ventilation for proper curing. Keep materials sealed when not in use.

F. Environmental conditions such as temperature and humidity to be within the ranges recommended by the coating manufacturer.

G. Finish coats to be smooth, free of brush marks, streaks, laps or pile up of paints, and skipped or missed areas. Finished metal surfaces to be free of voids or pinholes in any coat when tested with a low voltage detector.

3.02 EXAMINATION

A. Section 01700 – Contract Closeout: Requirements for application examination.

B. Verify that surfaces and substrate conditions are ready to receive Work as recommended by product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of Work, and report conditions capable of affecting proper application to Architect/Engineer.

D. Test shop-applied primer for compatibility with subsequent cover materials.

E. Moisture Content:

1. Measure moisture content of surfaces using electronic moisture meter.

2. Do not apply finishes unless moisture content of surfaces are below following maximums:

a. Plaster and Gypsum Wallboard: 12 percent.

b. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.

c. Interior Wood: 15 percent, measured according to ASTM D4442.

d. Exterior Wood: 15 percent, measured according to ASTM D4442.

e. Concrete Floors: 8 percent.

3.03 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.

B. General:

1. Perform all preparation and cleaning procedures in strict accordance with paint manufacturer’s instructions and as specified for each substrate.

C. Concrete Surfaces:

1. Prior to painting, surfaces to be free of all latent matter, burrs, and fins, using one or more of the following methods.

   a. Remove oil and grease with detergent and thoroughly rinse with fresh water.

   b. Abrasive blasting may be used only if machinery or other equipment in vicinity of work is adequately protected. Also, avoid settling of dust or grit on freshly painted surfaces.

   c. Wash concrete surfaces with 10 percent solution of muriatic acid, then wash clean and free of scale, mortar, dust, moisture, and other foreign matter.

   d. Repair all honeycomb surface defects by coating cleaned honeycombed area with epoxy bonding agent and filling voids with non-shrink grout leaving a smooth uniform concrete surface.

2. If curing compound is used, it must be removed prior to coating.

D. Metal Surfaces:

1. Clean metal surfaces by abrasive blasting in shop as required by Table 1 and leave clean, dry, and ready to receive prime coat. Provide moisture separators to effectively remove all oil and free moisture from air supply. Cleanliness of air to be tested by impinging an abrasive-free air stream onto a white cloth for one minute. If oil or moisture is detected, air source to be shut down and corrected.

2. Remove all dust and abrasives from surfaces by brushing or blowing with clean, dry air. Remove abrasive grit around and between joints of connecting members.

3. Perform field abrasive blasting only if required to correct unsatisfactorily cleaned and shop-primed metal and when approved by Engineer.

4. Removal of Oil and Grease: Remove oil and grease with a solvent approved by coating manufacturer, or by steam combined with detergent (in accordance with SSPC SP-1). Use of gasoline, kerosene, naphtha, or carbon tetrachloride not permitted.

5. Brushing, Scraping, Grinding, and Chipping: In field work, if abrasive blasting is not possible, scrapers, wire brushes, and other suitable grinding or chipping tools may be used (in accordance with SSPC SP-2 or SP-3) for removal of existing paint coatings prior to repainting, or for cleaning, before applying second coats.

6. Surface to be coated on same day as cleaned and before rust bloom occurs. Surfaces which have been cleaned but which have started to show signs of rust or dirt are to be cleaned again prior to coating at no additional expense to Owner.

7. All surfaces to be at least 5 degrees F or higher above the dew point and remain this way when blasting, priming, or coating.

E. Galvanized Surfaces:

1. Clean surface with mineral spirits to remove oil residue.

2. Dry with a clean cloth.

F. Wood Surfaces

1. Clean soiled surfaces in accordance with coating manufacturer's instructions.

2. Sand to a smooth even surface and then dust off.

3. Apply shellac to all knots, pitch and resinous sapwood before priming coat is applied.

4. Fill nail holes, cracks, open joints and other defects with putty after priming coat has dried. Tint putty to match finish color. Sand smooth after putty dries.

5. Apply priming coats to woodwork as soon as practical after woodwork is delivered.

6. Top and bottom edges of all wood doors to be primed and sealed after fitting and before final hanging.

G. Gypsum Wallboard

1. Fill narrow, shallow cracks and small holes with spackling compound.

2. Rake deep, wide cracks and deep holes.

a. Dampen with clean water.

b. Fill with thin layers of drywall joint compound

3. Allow repairs to dry.

4. Sand smooth. Do not raise nap of paper on wallboard.

3.04 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. General:

1. Do not apply initial coating until moisture content of surface is within limitations recommended by paint manufacturer. Test with moisture meter.

2. Slightly vary the color of successive coats.

3. Sand and dust between each coat to remove defects visible from a distance of 5 feet.

4. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.

5. Change colors at corner of stop where colors differ between adjoining spaces or rooms and where door frames match wall colors.

6. Do not proceed with field applied painting of shop-coated items until any defective work has been cleaned by sandblasting.

B. Brush Application:

1. Brushes: Use first-quality hog hair or suitable synthetic bristle brushes. Use of horsehair bristle brushes not permitted. Keep brushes clean and free from accumulation of dried paint or dirt, and when brushes for oil or varnish base paints are not in use, keep them suspended in raw linseed oil bath. Clean brushes with proper solvent before reuse.

2. Application: Apply in uniform thickness consistent with specified coverage and with sufficient cross-brushing to ensure filling of surface irregularities. Exercise particular care in painting around bolt heads and nuts and in corners and other restricted spaces.

C. Conventional Spray Application: Apply with adjustable air gun equipped with suitable water trap to remove moisture from compressed air, and with paint pot having air driven or mechanical agitator. Adjust width of spray to meet the requirements of the surface being coated with suitable air pressure for the particular type of paint being used. Make frequent checks to ensure correct spreading rate and coating and apply without sags, runs, or "orange peel" effect. Correct all such imperfections. Take special care to cover edges, corners, and bolt heads, without bridging over of paint film.

D. Airless Spray Application: Equipment used for airless spray to be designed for, and capable of handling, the volume and pressures necessary to ensure smooth and proper application. Hoses to be specifically designed for the viscosity of the material being sprayed and be of the non-static, self-grounding type. Tips to be properly sized to ensure complete atomization and the spray pattern is to be continuous and free of all fingering effects.

E. Roller Application: Proper length nap rollers to be used to ensure a smooth application free of runs, sags, roller marks, or air bubbles. Use longer nap for rougher surfaces when specified on PLANS. Phenolic core lamb's wool type rollers to be used when polyurethanes, epoxies, or other types activated coatings are applied by roller.

Standard type rollers to be used on water based and enamel coatings. Rollers to be of sufficient quality to leave finished surfaces free of lint, roller nap, runs, sags, and other imperfections. Roller is not to exceed 24 inches in length.

F. Metal Surfaces:

1. Shop-prime metal surfaces, if required, prior to delivery to job site.

2. After delivery and prior to installation, keep all coated metal surfaces clean and free from corrosion. Clean and touch up or repaint damaged areas with additional primer.

3. After erection or installation of metal work, clean and touch up all rust spots, all places where primer has been rubbed or scraped off, and all bolts and nuts. After previously applied paint has hardened, and when surfaces to receive succeeding coats of paint have been cleaned and dried, apply finish paint in accordance with Tables 1 and 2. Allow 7 days or more, as recommended by coating manufacturer, for curing of final coat for submerged surfaces.

4. Factory-Finished Equipment: After installation of factory-finished machinery and electrical equipment, check base coats carefully and touch up all damaged surface areas. Do not paint nameplates, serial number bases, chrome, or bronze trim. Clean off any excess paint that impairs convenient removal of covers on gauges, instrumentation, or other equipment fitted with doors or covers.

5. Factory-Primed Equipment: Delay final field coating to manufacturer’s primed equipment until equipment has been installed and is in proper working order in accordance with the applicable Section.

G. Mixing and Tinting:

1. Deliver paints and enamels ready mixed to job site.

2. Accomplish job mixing and job tinting only when acceptable to the Engineer.

3. Mix only in mixing pails placed in suitably sized non-ferrous or oxide resistant metal pails.

4. Use tinting colors recommended by manufacturer for the specific type of finish.

5. Multiple-Component Coatings:

   a. Prepare using all the contents of the container for each component as packaged by the manufacturer.

   b. No partial batches permitted.

c. Do not use multiple component coatings that have been mixed beyond their pot life.

d. Provide small quantity kits for touch up painting and for painting small areas.

e. Mix only components specified and furnished by coating manufacturer.

f. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

3.05 REPAIR/RESTORATION

A. Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners and depressions.

B. Remove all masking products used to protect hardware or built-in work.

C. Final Cleaning and Touchup:

1. Touch up and restore finish where damaged.

2. Do not mar surface finish of item being cleaned.

D. Refinish whole wall where portion of finish has been damaged or is not acceptable.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of coating manufacturer.

2. Repair fusion bonded coatings as recommended by original applicator. Applicator to furnish liquid repair kits for this purpose as recommended by the coating manufacturer.

3. Apply finish coats, including touch up and damage-repair coats, in a manner which presents a uniform texture and color-matched appearance.

F. Unsatisfactory Application:

1. If coating has improper finish color or insufficient film thickness: Clean and top coat surface with specified material to obtain specified color and coverage. Obtain and follow specific surface preparation information for top coating from coating manufacturer.

2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat in accordance with this Section.

Depending on extent of repair and appearance, a finish sanding and top coat may be required.

3. Evidence of runs, sags, bridges, shiners, laps, or other imperfections to be cause for rejection.

4. Repair defects in coating system per written recommendations of coating manufacturer.

5. Leave all staging in place until Engineer has inspected surface or coating. Replace staging removed prior to inspection and approval by Engineer.

3.06 FIELD QUALITY CONTROL

A. Schedule field operations to avoid settling of dust or grit on freshly painted surfaces, and adequately protect machinery or other equipment in vicinity of abrasive blasting work.

B. Request review by Owner of first finished room, space, or item, of each color scheme for color, texture, and workmanship.

C. Use first acceptable room, space or item (as determined by Owner), as project standard for each color scheme.

D. For spray application, paint an area no smaller than 100 square feet as the project standard.

3.07 CLEANING

A. During the progress of the work, remove from the project site at the close of each day's work, all oily rags, discarded materials, rubbish, cans, and dispose of in accordance with national, state, and local regulations.

B. On completion of operations, remove all spots, oil, and stain from all surfaces and leave entire project in clean condition as far as this work is concerned.

C. Remove from premises all containers and debris resulting from this work and dispose of in accordance with Federal, State and local regulations.

D. Upon completion of the work remove staging and scaffolding from the site.

3.08 TESTING AND INSPECTION

A. Contractor is to perform routine quality control testing on each coat to ensure the integrity of the protective coating. At a minimum, the following tests are to be performed.

1. Dry film thickness.

2. Holiday testing.

3. Any additional tests as recommended by coating manufacturer.

B. Any and all testing performed by the Engineer is for the sole purpose of verifying compliance with this specification. Contractor is not to rely upon testing performed by the Engineer as a means of quality control.

C. Contractor to provide the following equipment for use by the Engineer.

1. One magnetic pull-off type, non-destructive paint film thickness gauge, such as a Mikrotest thickness gauge. Thickness gauge to become Owner's.

2. One set of certified coating thickness calibration standards produced by the U.S. Department of Commerce. Calibration standards to become Owner's.

3. One "wet sponge," low voltage, D.C. type holiday detector, such as the Tinker-Rasor Electrical Holiday Detector.

D. Provide the Engineer with the proper safety equipment for observation and testing of the applied coating.

E. To facilitate Engineer's inspection of coated surfaces, Contractor to provide scaffolding/rigging and adequate illumination as required to perform the dry film thickness reading and holiday test inspections as required by this specification and the referenced standards. Provide personnel to move the scaffolding, lighting, or rigging at the request of the Engineer.

F. No equipment is to be placed in service until the protective coating has been tested and approved by the Engineer.

3.09 PROTECTION

A. Contractor is solely and completely responsible for conditions of the job site including safety of all persons (including employees) and property during performance of the work. This requirement applies continuously and is not limited to normal working hours. Conform with safety provisions of the U.S. Department of Labor, Occupational Safety and Health Act, any equivalent State law, and all other applicable Federal, State, and local laws, ordinances, and codes.

B. Protect floors and all other areas where work is done, with suitable drop cloths.

C. Remove, mask, or otherwise protect all hardware, hardware accessories, lighting fixtures, switchplates, machined surfaces, couplings, shafts, bearings, labels, nameplates, etc. and other surfaces not intended to be painted prior to surface

preparation and painting. Reinstall the removed items by workmen skilled in the trades involved.

D. Contractor is cautioned of the potential risk of damage and/or nuisance to the adjoining property and/or structures. Contractor is responsible for providing necessary equipment and/or controls to minimize the carryover of dust, paint, and abrasives. If excessive dust, paint, or abrasives are determined by the Owner, or their representative, to be affecting adjoining property and/or structures, Contractor to utilize shrouds, drop tubes, or other means to confine a minimum of 95 percent of the abrasive, paint, and other material to the associated work area.

E. Protect working parts of mechanical and electrical equipment from damage. Mask openings in motors to prevent paint and other materials from entering motor.

3.10 SCHEDULES

A. Attachments to this Section define System Schedule (Table 1) and Coating Schedule (Table 2).

TABLE 1 – SYSTEM SCHEDULE

Type of Surface	Exposure	Surface Preparation/ Cleaning	Table 2 – Material Reference				Minimum Total Mils Thickness
			Primer	1st Coat	2nd Coat	3rd Coat	
Polished Concrete Block	Exterior & Interior	Manufacturer's Specification	Spray on sealant as recommended by manufacturer of polished face CMU				
Concrete Block Walls	Interior - Painted	Paragraph 3.02 B	—	1	2	2	3.0 (Finish Coat)
Concrete Walls	Interior	Paragraph 3.02 B	—	1	2	2	3.0 (Finish Coat)
Wallboard (Egg Shell)	Interior	Manufacturer's Specification	7	8	10	10	4.0 + texture
Metal Doors & Frames	Exterior & Interior	NACE-#4 1.0 Mils Surface Profile	6	2	—	—	4.0
Structural and Misc. Steel	Interior	NACE-#3 1.0-2.0 Mils Surface Profile	4	5	—	—	5.5
Galvanized Steel	Interior	Solvent Cleaning	3	5	—	—	2.9

TABLE 2 – COATING SCHEDULE				
Sym-bol	**Min. Dry Mils Per Coat***	**Service**	**Generic Type**	**Brand and Manufacturer**
1.	NA	Primary Sealer	Acrylic Resin Surfacer	SW PrepRite Interior/Exterior Latex Block Filler (B25W25)
2.	1.5	Finish Coat	Epoxy Semi-Gloss	SW Pro Industrial Pre-Catalyzed Waterbased Epoxy Semi-Gloss (K46)
3.	.4	Galvanized Metal Primer	Single Component Water-Based Wash Primer	SW DTM Wash Primer (B66W1)
4.	3.0	Primer	Acrylic	SW Pro Industrial Pro-Cryl Universal Acrylic Primer (B66-310)
5.	2.5	Steel Interior – Semi-gloss	Acrylic	SW Pro Industrial Multi-surface Acrylic Semi-Gloss (B66-1550)
6.	2.0	Primer	Zinc Rich	SW Zinc Clad XI Water Based Inorganic Zinc Silicate Coating (B69V11/B69D11)
7.	NA	Texture	Acrylic	SW Tuff Surface Premium Texture Finish (A44W00350)
8.	1.2	Primer	Latex	SW ProMar 200 Zero VOC Interior Latex Primer (B28W02600)
10.	1.4	Finish Coat-Eg-Shel	Latex	SW ProMar 200 Zero VOC Eg-Shel Interior Latex (B20W12651)

Notes:

* Or manufacturer's standard, whichever is greater. Do not exceed manufacturer's maximum standard, if applicable.

END OF SECTION 09902

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means Dry Film Thickness.

C. The following surfaces shall not be coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.

2. Stainless steel

3. Machined surfaces

4. Grease fittings

5. Glass

6. Equipment nameplates

7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

8. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

B. Reference Specifications

01300	Submittals

01600	Materials and Equipment

1.03 REFERENCES

A. Reference Standards

ASTM International (ASTM)	
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D3276	Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D4060	Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D6386	Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
American Water Works Association (AWWA)	
AWWA D102	Coating Steel Water-Storage Tanks
ANSI/AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
NACE International (NACE)	
NACE RP0287-02	Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
Occupational Safety and Health Administration (OSHA)	
OSHA 29CFR1910.1200	Hazard Communication
Society for Protective Coatings (SSPC)	
SSPC Guide 12	Guide for Illumination of Industrial Painting Projects
SSPC PA 1	Shop, Field, and Maintenance Coating of Metals

SSPC PA Guide 11	Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
SSPC SP 1	Solvent Cleaning
SSPC SP 2	Hand Tool Cleaning
SSPC SP 3	Power Tool Cleaning
SSPC SP 5/NACE No. 1	White Metal Blast Cleaning
SSPC SP 6/NACE 3	Commercial Blast Cleaning
SSPC SP 7/NACE 4	Brush-off Blast Cleaning (NACE No. 4)
SSPC SP 10/NACE 2	Near-White Blast Cleaning
SSPC SP 11	Power Tool Cleaning to Bare Metal
SSP SP 13	Surface Preparation of Concrete

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals.

B. Submittals shall include the following information and be submitted at least 30 Days prior to commencing protective coating Work:

1. Materials List: A copy of a coating materials list showing the manufacturer and the product number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submitting samples.

2. Manufacturer's Information: For each coating system to be used, the following data:

a. Manufacturer's data sheet for each proposed product

b. Manufacturer’s statements on the suitability of the proposed products for the intended use. Include in the statement confirmation that the coating manufacturer’s technical engineering representative inspected all existing substrate and/or surfaces with existing coatings and confirmed that the proposed products, application procedures and surface preparation requirements are compatible with the coatings required by this Section.

c. Technical and performance information that demonstrates compliance with the system performance and material requirements.

d. Paint manufacturer's instructions and recommendations on surface preparation and application.

e. Colors available for each product (where applicable).

f. Compatibility of shop and field applied coatings (where applicable).

g. Safety Data Sheet for each product proposed.

C. Samples

1. Samples of paint, finishes, and other coating materials shall be submitted on 8-1/2 inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one protective coating material, type, and color.

2. Two sets of color samples to match each color selected by the OWNER from the manufacturer's standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the OWNER.

3. One 5 pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

D. Experience Requirements of the Field Applicator:

1. Submit a project organization chart showing the full name and clear lines of responsibility and duties for all personnel scheduled to perform work (including office managers, quality control supervisor and safety supervisor) on the project.

2. Submit for documentation a statement on company letter head indicating the name of the Quality Control Supervisor (QCS) who has been given written authority by executive management to perform the duties of the QCS position for the project. Include in the statement the date of last successful completion of training to perform the QCS position. Acceptable coating inspection training programs include at a minimum: SSPC (PCI, NBPI, BCI) Level 1, KTA Level 1, GPI (Level 1), NACE (CIP Level 1, Frosio) or equivalent formal in-house inspection training conforming to ASTM D3276.

3. Submit for documentation the set of procedures that have been implemented for conducting and documenting training (as needed) and for qualifying trainees, newly hired craft workers and newly hired experienced workers. Include documentation of annual proficiency evaluation system for all craft workers.

4. Submit for documentation up-to-date experience, training certificates, and licenses for all personnel scheduled to perform work on the project.

5. Submit for documentation a statement on company letter head that key personnel (including but not limited to, project management and QCS) have reviewed the project contract documents and specifications in effect at contract award. Include in the statement confirmation that the project contract documents, and specifications have been distributed to all affected personnel within the organization scheduled

to perform work on the project. Include in the statement the procedure for recording receipt and distribution of specifications and contract documents and all changes and revisions to contract documents. Include in the statement the procedures for documenting verbal responses from the Owner for requests for clarification.

6. Submit references of successfully completed projects for industrial coating projects completed within the last 18 calendar months. Acceptable references shall include contact information for owner staff having direct connection with the project, copies of facility owner project performance evaluations, letters of commendation from the owner or prime CONTRACTOR, statements of final payment, and punch list acceptance.

E. Quality Assurance Plan

1. Submit for review the written project-specific Quality Control Program to be followed. Primary duties and responsibilities of the QCS as outlined in the Quality Control Program shall include but are not limited to the following:

   a. Ensuring that qualified personnel perform the Work on the project.

   b. Ensure that proper inspection forms and recording procedures are used for job quality monitoring (including those required herein).

   c. Ensure correct and properly operating and calibrated equipment is used.

   d. Review and sign off on Daily Inspection Reports (DIRs) on a timely basis (QCS must sign off or authorize review of DIRs by other competent QC personnel).

   e. Ensure that Work is inspected for conformance with the contract requirements, good painting practice, and internal Quality Control (QC) procedures.

   f. Ensure that nonconforming work and rework is properly documented.

   g. Develop and/or review Inspection and Test Plans.

   h. Conduct and/or review internal audits.

2. Submit for documentation written project-specific procedures for all production processes to be used on the project. The procedures shall include, but are not limited to the following:

   a. Standard company or contract specific procedures are available to and used by on-site personnel for verifying that coating and related operations are performed in accordance with contract requirements and industry best practices.

b. Inspection procedures or project specific inspection plans ensuring that all work is properly performed and documented daily during coating operations or documented in accordance with contract requirements, are available to site personnel, and are used to perform in-process inspections of work at key hold points.

c. Abrasive blasting (dry or wet) and related processes

d. Water jetting and related processes

e. Hand and power tool cleaning and related processes

f. Coating mixing and related processes

g. Coating application (e.g., brush, roller, spray, mitt) and related processes

h. Top coating procedures (e.g., conditions when meeting and exceeding recoat windows)

i. Curing process for materials applied

j. Erecting, moving, and tearing down containment

k. Field audits performed on site confirming equipment is in good operating condition

3. Submit for review and documentation Daily Inspection Reports (DIRs) to Engineer on a weekly basis. All DIRs and testing results shall be maintained on file for the duration of the project. DIRs must be signed and dated by the CONTRACTOR and formally reviewed by the QCS. DIRs and other daily reports shall record project relevant observations including:

   a. Compressed air cleanliness

   b. Air temperature (dry and wet bulb)

   c. Relative humidity

   d. Dew point

   e. Substrate surface temperature

   f. Abrasive cleanliness

   g. Surface preparation cleanliness specified and achieved

   h. Surface profile specified and achieved

i. Illumination of work area (foot candles for surface preparation, coating application, and inspection) in accordance with SSPC Guide 12 recommendations or contract requirements.

j. Batch numbers of coatings and thinners

k. Mixing of coatings (in accordance with coating manufacturer's mixing instructions)

l. DFT readings for each applied coating meeting specification requirements.

m. Inspection instruments used (manufacturer, model, and serial number)

n. Storage temperature and storage conditions to include min/max daily, or as required.

1.05 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. Nonconforming work, identified by CONTRACTOR QC personnel, Owner, ENGINEER or OWNER's Representative performing QA on behalf of the Owner shall be documented and repaired.

B. Inspection: An inspection may be conducted during the eleventh month following completion of coating Work. The CONTRACTOR and a representative of the coating material manufacturer shall attend this inspection. Defective Work shall be repaired in accordance with these specifications and to the satisfaction of the Owner. The Owner may, by written notice to the CONTRACTOR, reschedule the inspection to another date within the one-year correction period or may cancel the inspection altogether. The CONTRACTOR is not relieved of its responsibilities to correct defects, whether or not the inspection is conducted.

1.06 COMPLIANCE WITH VOLATILE ORGANIC COMNPOUND (VOC) LIMITS

A. All paint and coating products shall comply with the applicable limits on volatile organic compounds (VOCs) as established by the United States Environmental Protection Agency and by state and local air quality regulating agencies. It shall be the CONTRACTOR's responsibility to verify compliance of all paints and coatings.

PART II - PRODUCTS

2.01 GENERAL

A. Suitability: The CONTRACTOR shall use suitable coating materials as recommended by the manufacturer.

B. Material Sources: Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and the CONTRACTOR shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. Compatibility: In any coating system only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. Containers: Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

E. Colors: Colors and shades of colors of coatings shall be as indicated or selected by the Engineer. Each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the Engineer.

2.02 INDUSTRIAL COATING SYSTEMS

A. System 1 - Acrylic Polymer

1. Materials

Primer	Manufacturer's recommendation
Finish Coat	1 component water-based acrylic
Type	Pure acrylic emulsion
Demonstrated suitable for	ferrous and nonferrous surfaces in industrial exposure, producing high gloss surface that is resistant to mild corrosion and chemical fumes, has good color and gloss retention, good weathering, and sunlight resistance
VOC Content, max (g/L)	450

2. Application and manufacturers

Prime Coat (DFT = 2 to 4 mils)	**Finish Coat (DFT = 2 to 4 mils)**	**Total System DFT**
PPG Pitt Tech Plus	PPG Pitt Tech Plus	4 to 8 mils
Tnemec Series 115 Unibond	Tnemec Series 1028 Enduratone for Gloss finish (use Series 1029 for Semi-Gloss finish)	
Carboline Sanitile 120	Carbocrylic 3359 Series	
Sherwin Williams Pro Industrial Procryl	Sherwin Williams Pro Industrial Acrylic	

B. System 2 - Organic Zinc/Epoxy/Polysiloxane

1. Materials

Primer	organic zinc
Intermediate coat	Epoxy
Finish Coat	
Type	Polysiloxane
Demonstrated suitable for	Long term outdoor exposure and color retention
VOC Content, max	450 grams per liter

2. Application and manufacturers

Prime Coat (DFT = 3 to 5 mils)	**Intermediate Coat (DFT = 4 to 8 mils)**	**Finish Coat (DFT = 4 to 6 mils)**	**Total Min DFT**
Sherwin Williams Corothane Galvapac 1K MCU or Zinc Clad III HS	S-W Macropoxy 646- B58 Serieis	Sherloxane 800	11 mils
Carboline Carboxane 850	Carboline Carboguard 890 Series	Carboline Carboxane 2000	
PPG Amercoat 68HS		PPG PSX 700	
Tnemec Series 94H2O HydroZinc	Tnemec Series N69 Hi-Build Epoxoline II	Tnemec Series 690 Tnemec Polysiloxane	

C. System 3 - Aluminum Silicone

1. Materials

Type	High heat silicone with aluminum
Demonstrated suitable for	Ferrous surfaces, continuous temperatures of 1000 deg F
VOC Content, max (g/L)	450

2. Application and manufacturers

Total System DFT = 3 mils
Carboline Thermaline 4700 Series - Aluminum, 2 coats
Sherwin William Hi-Temp Coatings 1000V, 2 coats.

D. System 4 - Epoxy/Polyurethane

1. Materials

Primer type	2 component epoxy
VOC Content, max (g/L)	450
Finish type	2 component aliphatic polyurethane
VOC Content, max (g/L)	450
Demonstrated suitable for	ferrous surfaces, superior color and gloss retention, exceptional resistance to weathering, chemical fumes, and splash

2. Application and manufacturers

Prime Coat (DFT = 3 - 5 mils)	**Finish Coat (DFT = 3 - 4 mils)**	**Total System DFT**
Carboline Carboguard 890	Carbothane 134 HG	6 - 9 mils
Tnemec Hi-Build Epoxoline II Series L69	Tnemec Endura-Shield Series 1094 for Gloss finish (use Series 1095 for Semi-Gloss finish)	
PPG Amerlock 2/400	Amershield	
Sherwin Williams Macropoxy 646	S W Hi-Solids Polyurethane	

E. System 5 - Inorganic Zinc/Epoxy/Polyurethane

1. Materials

Prime Coat	Inorganic zinc silicate, water-based, 2 component
Zinc content in dry film	79 percent, minimum
VOC content, max (g/L)	0
Demonstrated suitable for	Ferrous metal, providing superior corrosion, chemical, and abrasion resistance, recommended for use as primer under epoxy
Intermediate Coat	2 component epoxy, high build, recommended by manufacturer for application over inorganic zinc primer
Demonstrated suitable for	Outstanding chemical, corrosion, and abrasion resistance
VOC content, max (g/L)	450
Finish Coat	2 component aliphatic or acrylic polyurethane
Demonstrated suitable for	Superior color and gloss retention, resistance to chemical fumes, severe weathering, and abrasion
VOC content, max (g/L)	450

2. Application and manufacturers

Surface preparation for primer		SSPC SP 10	
Anchor profile for primer		per manufacturer	
Prime Coat (DFT = 3 - 4 mils)	**Intermediate Coat (DFT = 4 - 6 mils)**	**Finish Coat (DFT = 3 - 4 mils)**	**Total System DFT**
PPG- Dimetcote 21-5	PPG Amerlock 2/400	Amershield	10 - 14 mils
Carboguard Carbozinc 11 VOC	Carboline Carboguard 890 Series	Carbothane 134 HG	

Tnemec Tneme-Zinc 94H20	Tnemec Series L69	Tnemec Endura-Shield Series 1094 for Gloss finish (use Series 1095 for Semi-Gloss finish)	
Sherwin Williams Zinc Clad III HS 100	S W Macropoxy 646	S-W Hi-Solids Polyurethane 250	

F. System 6 - Inorganic Zinc, Water Based

1. Materials

Type	water based zinc silicate, 2 component
Percent Zinc in dry film	83, min
VOC Content, max (g/L)	0
Demonstrated suitable for	Severe weathering and moderate chemical fumes, continuous temperatures of 600 deg F

2. Application and manufacturers

Product (single coat)	Total System DFT
PPG- Dimetcote 21-5	4 - 8 mils
Devoe Cathacoat 305	
Carboline Carbozinc 11 WB	
Sherwin Williams Zinc Clad XI	

G. System 7 - Epoxy, High Heat Under Thermal Insulation Wrap

1. Materials

Type	Epoxy, High Heat under Thermal Insulation Wrap
VOC Content, max	450 grams per liter
Demonstrated suitable for	Protection of iron and steel surfaces that may experience elevated temperatures up to 600 deg F under thermal insulation wrap; Do not use for atmospheric exposed conditions; Do not use for stainless steel.

2. Application and manufacturers

Product (2 coats at 2 - 4 mils each)	**Total System DFT**
PPG Hi-Temp 1027 HD	4 - 8 mils
Sherwin Williams EpoPhen	
Carboline Thermaline 450	

H. System 8 - Epoxy, Equipment

1. Materials

Primer Type	2 component epoxy
Demonstrated suitable for	Rust inhibitive, outstanding chemical, abrasion, and weathering resistance, resistance to splash, washdown, and condensation. Immersion capability is not required
VOC content, max (g/L)	450
Finish Type	2 component epoxy, available in many colors
Demonstrated suitable for	Outstanding chemical, abrasion, and weathering resistance, resistance to splash, washdown, and condensation. Immersion capability is not required
VOC content, max (g/L)	450

2. Application and manufacturers

Prime Coat (DFT = 4 - 5 mils)	**Finish Coat (DFT = 4 - 5 mils)**	**Total System DFT**
PPG- Amerlock 2/400	PPG Amerlock 2/400	8-10 mils
Tnemec Series N69	Tnemec Series N69	
Carboline Carboguard 890 Series	Carboline Carboguard 890 Series	
Sherwin Williams Macropoxy 646	Sherwin Williams Macropoxy 646	

I. System 9 - Inorganic Zinc/Epoxy, Equipment

1. Materials

Primer type	Water-based inorganic, self-curing zinc silicate
Zinc content in dry film	83 percent, min
Demonstrated suitable for	Superior corrosion, chemical and abrasion resistance, recommended as primer under epoxy
Finish type	2 component polyamide epoxy
VOC Content, max (g/L)	450
Demonstrated suitable for	Good resistance to chemical attack, weathering, splash, washdown, and condensation, available in many colors

2. Application and manufacturers

Prime Coat (DFT = 3 to 5 mils)	**Finish Coats (2 or more) (DFT = 4 to 6 mils each)**	**Total System DFT**
Carboline Carbozinc 11VOC	Carboline Carboguard 890 Series	11-17 mils
PPG- Dimetcote 21-5	Amerlock 2/400	
Sherwin Williams Zinc Clad III HS	S-W Macropoxy 646	

J. System 10 - Acrylic, Concrete

1. Materials

Filler-Sealer Type	Epoxy or acrylic masonry sealer, for concrete and CMU, for wet and dry conditions
Primer	as recommended by manufacturer
VOC Content, max (g/L)	450
Finish Type	single component waterborne pure acrylic emulsion, industrial grade, high molecular weight
VOC Content, max (g/L)	450
Demonstrated suitable for	concrete under mild to moderate exposure conditions, splash but not immersion

2. Application and manufacturers

Prime Coat (Filler-Sealer)	**Finish Coat (DFT = 5 - 7 mils) (2 or more coats)**	**Total System DFT**
Tnemec EnviroFill Series 130	Tneme-Crete 180 Series	5 - 7 mils plus primer
PPG- Amerlock 400BF and/or Amercoat 965	PPG Pitt-Tech Plus Series	
Carboline Sanitile 500	Carboline - Carbocrylic 3359 DTMC	
Sherwin Williams Pro Industrial Heavy Duty Block Filler	Sherwin Williams Pro Industrial Acrylic	

K. System 11 - Not Used

L. System 12 - Polyurethane, Fiber Glass

1. Materials

Primer Type	as recommended by manufacturer
Finish Type	2 component aliphatic polyurethane
Demonstrated suitable for	Fiberglass, superior color and gloss retention, resistance to acid and alkali splash, fumes, and severe weathering, no immersion
VOC content, max (g/L)	450

2. Application and manufacturers

Prime Coat (3 to 4 mils)	**Finish Coats (4 to 6 mils)**	**Total System DFT**
Carboline Carboguard 890 Series	Carboline - Carbothane 134 HG	7-10 mils
PPG Amerlock 2/400	Amershield	
Tnemec Hi-Build Epoxoline II Series N69	Tnemec Series 1095 Endura-Shield	
Sherwin Williams Macropoxy 646	S-W Hi-Solids Polyurethane 250	

2.03 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. System 100 - Amine Cured Epoxy

1. Materials

Type	high build, amine cured epoxy
VOC content, max (g/L)	450
Demonstrated suitable for	steel, long-term immersion in water and wastewater, resistant to corrosion, chemical fumes, good color retention

2. Application and manufacturers

Products (3 coats or more)	**Total System DFT**
PPG Novaguard 840	15 to 17 mils For non-submerged valves and other equipment, DFT = 10 to 12 mils
Carboline Carboguard 891 VOC	
Hi-Build Epoxoline II Series N69 for wastewater	
Sherwin Williams Tank Clad HS	

B. System 101 - (Not used)

C. System 102 - Polyamide Epoxy

1. Materials

Type	high build polyamide cure epoxy
VOC content, max (g/L)	450
Demonstrated suitable for	long term immersion in water resistant to corrosion and chemical fumes, good color retention
Certification	NSF 61 if in contact with potable water

2. Application and manufacturers

Products (3 coats or more)	**Total System DFT**
Tnemec Series 21 Epoxoline	12-18 mils
PPG- Amerlock 2/400	

Carboline - Carboguard 61	
Sherwin Williams Macropoxy 646 PW	

D. System 103 - Not Used

E. System 104 - Not Used

F. System 105 – Not Used

G. System 107 - Chemical Resistant Sheet Lining:

1. Materials: The CONTRACTOR shall use natural rubber, chlorobutyl rubber, ethylene propylene diene monomer (EPDM) rubber, chloroprene polymer (neoprene) rubber, or chlorosulfonated polyethylene (Hypalon) rubber sheet lining materials as indicated. The Shop Drawing submittal shall contain technical information that confirms the suitability of the lining material system for long-term immersion in each chemical to be stored. The service temperatures are expected to be up to 150 degrees F.

2. Neoprene sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16 - inch. The lining material shall be Polymeric Protective Linings BFG 2011 (59688), or equal.

3. Chlorobutyl sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be Polymeric BFG 1051 (60924), or equal.

4. Natural rubber (soft) sheet lining material shall be soft natural rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be Polymeric BFG 2004 (83160), or equal.

5. Natural rubber (hard) sheet lining material shall be a hard, natural rubber resistant to oxidizing agents and formulated for autoclave curing. The minimum lining thickness shall be 3/16-inch. The lining material shall be Polymeric BFG 1006 (8631), or equal.

6. EPDM sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution and formulated for autoclave or steam curing under pressure. The lining material shall be Polymeric BFG 1039 (EP156), or equal.

7. Hypalon sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution. The lining material shall be Polymeric BFG 2045 (8706), or equal.

8. Primers, adhesives, activators, accelerators and other necessary materials shall be as required by the sheet material manufacturer.

9. Metal Surface Preparation: Prior to abrasive blast cleaning the base metal shall be prepared as required by the sheet lining material manufacturer's installation instructions. If the instructions differ from these specifications, the highest degree of cleaning and surface preparation shall be provided. Abrasive blast cleaning shall be done in accordance with this Section.

10. Installation of lining materials shall be in accordance with the material manufacturer's written installation instructions. All interior surfaces shall be lined, including all piping, vents, fittings, flange faces, manhole covers, and blind flanges.

11. The lining system shall be holiday tested in accordance with this Section before and after curing.

12. The lining system shall be cured by steam using the time and temperature as required by the material manufacturer.

H. System 108 - Polyurethane, Concrete

1. Materials

Filler-sealer type	epoxy material with portland cement and aggregate
Primer type	Phenolicamine or polyamidoamine epoxy
VOC content, max (g/L)	450
Finish type	aromatic elastomeric polyurethane
Demonstrated suitable for	concrete and concrete block masonry, long term immersion in water and wastewater and service where subject to splash and spill of water and wastewater treatment chemicals
VOC content, max (g/L)	450
Certification requirement, where coating will be in contact with potable water	NSF 61/600

2. Application and manufacturers

Filler-Sealer	**Primer** **DFT = 3 - 7-mils**	**Finish Coat** **DFT = 100 - 125 mils, 75 mils for potable water**

Carboline – Carbocrete 4010	Carboline -Carboguard 1340 WB (Optional)	Carboline -Reactamine 760
Tnemec MortarClad 218	Tnemec Pota-Pox L140 (potable water) Epoxoprime 201 (wastewater)	Elasto-Shield 406 (max 75 mils for potable water)
PPG-Amercoat 100A	PPG Raven 175	PPG Aquataflex 505
Sherwin Williams Steel Seam FT 910	Sherwin Williams Macropoxy 5000	Sherwin Williams Polycote 115

I. System 109 - Epoxy, Concrete, Manhole Liner

1. Materials

Filler-sealer type	Epoxy material with portland cement and aggregate
Primer type	100 percent solids epoxy
VOC content, max (g/L)	450
Finish type	Amine cure epoxy/aggregate-filled epoxy
Demonstrated suitable for	Sewer manhole & wastewater facility, long term immersion in wastewater service where subject to chemical and bacteriological attack found in municipal sanitary sewer system

2. Application and manufacturers

Filler-Sealer	**Primer** **DFT = 5 – 10 mils**	**Finish Coat** **DFT = 125 – 150 mils**
PPG Raven 210	PPG Raven 155	PPG Raven 405 FS
Sherwin Williams Duraplate 2300	Sherwin Williams Macropoxy 5000	Sherwin Williams Duraplate 6000, 6100
	Carboline-Carboguard 1340 WB (optional)	Carboline-Plasite 4500/4500S or Ractamine 760

2.04 SPECIAL COATING SYSTEM

A. System 200 - PVC Tape: Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.

B. System 201 - Rich Portland Cement Mortar: Rich Portland cement mortar coating shall have a minimum thickness of 1/8-inch, followed by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped and sealed with tape.

C. System 202 - (Not used)

D. System 203 - Epoxy Surfacing on Concrete Floors

1. Materials

Type	2 component epoxy floor surfacing
Demonstrated suitable for	concrete, resistance to abrasion and many acids and alkalis such as liquid alum, sodium hydroxide, and sulfuric acid
VOC Content, max (g/L)	450

2. Application and manufacturers

Primer/Sealer	**Finish Coat (1/4-inch thick)**
PPG Flooring - Concrete Epoxy Primer	PPG Flooring - Self Leveling Epoxy
Tnemec Power-Tread 237	Tnemec Power-Tread 237
Carboline Semstone 110 or Dudick Primer 67	Carboline Semstone 145 SL or Dudick Protecto-Coat 100XT
Sherwin Williams Resuprime 3579	Sherwin Williams Resulflor Screed TG46

E. System 204 - Water Retardant, Concrete

Type	silane-modified siloxane
Demonstrated suitable for	repelling water from vertical concrete and masonry surfaces
VOC Content, max (g/L)	450
Products, or equal	Sherwin Williams H&C Super V (315 g/l) or Loxon 7 percent Siloxane Water Repellent (0 VOC

F. System 205 - Polyethylene Encasement: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

G. System 206 - Cement Mortar Coating: A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than one part Type V cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane Forming Compounds for Curing Concrete," ASTM C 309, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all edges and joints lapped by at least 6-inches.

H. System 207 - Not Used

I. System 208 - Aluminum Metal Isolation

1. Materials

Type	high build polyamide epoxy with chemical and abrasion resistance
Demonstrated suitable for	concrete and aluminum substrates, to isolate aluminum from contact with concrete and the resulting chemical degradation
VOC content, max (g/L)	450

2. Application and manufacturers

Coating (DFT = 16 - 20 mils)
PPG Sigmashield 880
Sherwin Williams Macropoxy 646
Tnemec Epoxoline Series N69
Carboline - Carboguard 890 Series

J. System 209 - Not Used

K. System 210 - Acrylic, Wood and Gypsum Board

1. Materials

Primer type	as recommended by manufacturer
Finish type	single component, water based, acrylic, fungicide added
VOC content, max (g/L)	450

Demonstrated suitable for	wood, mild to moderate exposure inside and outside building, and gypsum board, inside

2. Application and manufacturers

Prime Coat (1.5 to 2.5 mils)	**Finish Coat (4 to 6 mils) (2 coats)**	**Total System DFT**
PPG- Gripper	PPG Pitt-Tech Plus	5.5 to 8.5 mils
Carboline - Carbocrylic 120		
Tnemec Series 115 Unibond	Tnemec Series 1028 Enduratone	
Sherwin Williams PrepRite ProBlock	Sherwin Williams Pro Industrial Acrylic	

L. System 211 – Novolac Epoxy, Concrete, Aggregate Filled, Secondary Containment, foot traffic

1. Topcoat Material

Type	Novolac epoxy, 60 – 75 mil resin system
Demonstrated suitable for	Chemical storage or feed pump areas subject to foot traffic. See Coating System Schedule, Concrete Surfaces of Chemical Secondary Containment in Part 3 for specific chemical applications

2. Application and manufacturers

a. TNEMEC

1) Surface Filler: Series 215, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations.

3) Primer: Series 201 Epoxyprime, 5-6 mils DFT

4) Base Coat: Series 239C, 25-30 mils DFT

5) Aggregate Fill, 20/40 mesh silica or garnet aggregate

6) Top Coat: Series 282 15-20 mils DFT

b. CARBOLINE

1) Surface Filler: Semstone 110 blended with fine silica and thixotrope Part D, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations, see paragraph 3.10.

3) Primer: Semstone 110, 5-6 mils DFT or Dudick Primer 67, 3-4 mils DFT.

4) Base Coat: Semstone 145, 25-30 mils DFT or Dudick Protecto-Coat 100XT, 15-20 mils DFT.

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat: Semstone 145, 15-20 mils DFT or Dudick Protecto-Coat 100XT, 15-20 mils DFT.

c. SHERWIN WILLIAMS

1) Surface Filler: Epoxy Mortar, Duraplate 2300, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations, see paragraph 3.10.

3) Prime: Corobond 100 Epoxy Primer, B58 Series, 5-6 mils DFT

4) Base Coat: Cor Cote E.N. 7000, 25-30 mils DFT.

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat : Cor Cote E.N. 7000, 15-20 mils DFT.

d. PPG

1) Prime: Milamar ICO Primer LV

2) Base Coat: Milamar ICO Hi Guard Coating

3) Top Coat: Milamar ICO Hi Guard Coating

M. System 212 – Vinyl Ester, aggregate filled, concrete, secondary containment, foot traffic

1. Topcoat Material

Type	Vinyl ester, 60 - 70 mil, aggregate filled resin system
Demonstrated suitable for	Chemical storage or feed pump areas subject to foot traffic. See Coating System Schedule, Concrete Surfaces of Chemical Secondary Containment in Part 3 for specific chemical applications.

2. Application and manufacturers

a. TNEMEC

1) Surface Filler: Series 215, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations.

3) Primer: Series 201 Epoxyprime, 4-12 mils DFT

4) Base Coat: Series 252SC, 6-12 mils DFT

5) Aggregate Fill, 20/40 mesh silica or garnet aggregate

6) Top Coat: Series 252SC, 15-20 mils DFT

b. CARBOLINE

1) Surface Filler: Semstone 110 blended with fine silica and thixotrope Part D, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations, see paragraph 3.10.

3) Primer: Semstone 110, 6-8 mils DFT or Dudick Primer 27, 3-4 mils DFT.

4) Base Coat: Semstone 870, 25-30 mils DFT or Dudick Protecto-Coat 800/805, 15-20 mils DFT.

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat: Semstone 870, 15-20 mils DFT or Dudick Protecto-Coat 800/805, 15-20 mils DFT.

c. SHERWIN WILLIAMS

1) Prime: Magnalux Vinyl Ester Primer, 5-6 mils DFT

2) Surface Filler: Epoxy Mortar, Magnalux 1500, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

3) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations, see paragraph 3.10.

4) Base Coat: Magnalux VEN, 25-30 mils

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat: Magnalux VEN, 15-20 mils

d. PPG

1) Prime: Milamar 6000 Primer

2) Base Coat: Milamar 6850 CS

3) Top Coat: Milamar 6850 CS

N. System 213 – Novolac Epoxy, Fiber Reinforced, Concrete, Secondary Containment, Truck Traffic

1. Topcoat Material

Type	Novolac epoxy, fiber reinforced, 110 - 125 mil mortar system
Demonstrated suitable for	Chemical unloading areas subject to truck traffic. See Coating System Schedule, Concrete Surfaces of Chemical Secondary Containment in Part 3 for specific chemical applications

2. Application and manufacturers

a. TNEMEC

1) Primer: Series 21, 4-12 mils DFT

2) Mortar Base Coat: Series 239SC, aggregate filled, 60-80 mils DFT

3) Fiberglass Reinforcement Cloth: ¾ ounce fiberglass mat

4) Saturant Coat: Series 239SC, 8-24 mils DFT

5) Aggregate Fill, 20/40 mesh silica or garnet aggregate

6) Top Coat: Series 239SC, 15-20 mils DFT

b. CARBOLINE

1) Primer: Semstone 110, 6-8 mils DFT or Dudick Primer 67, 3-4 mils DFT.

2) Mortar Base Coat: Semstone 145 AFC, aggregate filled, 60-80 mils DFT or Dudick Protecto-Coat 100XT, aggregate filled, 60-80 mils DFT.

3) Fiberglass Reinforcement Cloth: ¾ ounce fiberglass mat

4) Saturant Coat: Semstone 145, 8-12 mils DFT

5) Aggregate Fill, 20/40 mesh silica or garnet aggregate

6) Top Coat: Semstone 145 AFC, 15-20 mils DFT or Dudick Protecto-Coat 100XT, 15-20 mils DFT.

c. SHERWIN WILLIAMS

1) Prime: Corobond 100 Epoxy Primer, B58 Series, min. 4 mils DFT.

2) Base Coat: Cor Cote HCR, B62 Series, 6-12 mils DFT. .

3) Fiberglass Reinforcement Cloth: ¾ ounce fiberglass mat

4) Saturant Coat: Cor Cote HCR Clear with fiberglass reinforcement cloth above, 20-30 mils DFT.

5) Dura-Plate 8200, 8-10 mils DFT with full broadcast of 20/40 mesh aggregate

6) Finish Coat 2: Cor Cote E.N. 7000, 15 – 20 mils DFT. .

d. PPG

1) Prime: Milamar ICO Primer LV

2) Base Coat: Milamar ICO Super Guard Coating

3) Top Coat: Milamar ICO Super Guard Coating

O. System 214 – Vinyl Ester, Fiber Reinforced, Concrete, Secondary Containment, Truck Traffic

1. Topcoat Material

Type	Vinyl ester, fiber reinforced, mortar system, 110 - 125 mil DFT
Demonstrated suitable for	Chemical unloading areas subject to truck traffic. See Coating System Schedule, Concrete Surfaces of Chemical Secondary Containment in Part 3 for specific chemical applications

2. Application and manufacturers

a. TNEMEC

1) Primer: Series 251SC Chembloc, 4-12 mils DFT

2) Mortar Base Coat: Series 252SC Chembloc, aggregate filled, 60-80 mils DFT

3) Fiberglass Reinforcement Cloth: ¾ ounce fiberglass mat

4) Saturant Coat: Series 252SC, 8-12 mils DFT

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat: Series 252 Chembloc, 15-20 mils DFT

b. SHERWIN WILLIAMS

1) Prime: Corobond 100 Epoxy Primer, B58 Series, min. 4 mils DFT. .

2) Mortar Base Coat: Cor Cote VEN, aggregate filled, 60-80 mils

3) Fiberglass Reinforcement Cloth: ¾ ounce fiberglass mat

4) Saturant Coat: Magnalux 1200, 8-12 mils DFT.

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat: Cor Cote VEN, 15 – 20 mils DFT.

c. PPG

1) Prime: Milamar 6000 Primer

2) Base Coat: Milamar 6875 LS

3) Top Coat: Milamar 6850 CS

PART IIII - EXECUTION

3.01 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall require the protective coating manufacturer to furnish a qualified technical representative to visit the Site for technical support as may be necessary to resolve field problems.

B. For submerged and severe service coating systems, the CONTRACTOR shall require the paint manufacturer to furnish the following services:

1. The manufacturer's representative shall provide at least 6 hours of on-Site instruction in the proper surface preparation, use, mixing, application, and curing of the coating systems.

2. The manufacturer's representative shall observe the start of surface preparation, mixing, and application of the coating materials for each coating system.

3.02 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on coating Work.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. Damage to other surfaces resulting from the Work shall be cleaned, repaired, and refinished to original condition.

3.03 STORAGE. MIXING, AND THINNING OF MATERIALS

A. Manufacturer's Recommendations: Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.

B. Coating materials shall be used within the manufacturer's recommended shelf life.

C. Storage and Mixing: Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.04 PREPARATION FOR COATING

A. General: Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The CONTRACTOR shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Protection of Surfaces Not to be Coated: Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent Work during blasting operations. Spraying shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent Work or adjoining property occurring from blasting or coating operations.

E. Protection of Painted Surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly coated surfaces.

3.05 ENVIRONMENTAL REQUIREMENTS

A. No coating work shall be performed under the following conditions:

1. Surface or ambient temperatures exceed the manufacturer’s recommended maximum or minimum allowable.

2. Dust or smoke laden atmosphere.

3. Damp or humid conditions, where the relative humidity is above the manufacturer's maximum allowable.

4. Substrate and ambient temperatures are less than 5°F above the dew point and are decreasing. Dew point shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables. Elcometer 319 Dew Point meter or equal may also be used.

5. Ambient temperature that is expected to drop below 50 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

3.06 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. Solvent Cleaning (SSPC SP 1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC SP 2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC SP 3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC SP 5/NACE 1): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC SP 6/NACE 3): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC SP 7/NACE 4): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC SP 10/NACE 2): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. Power Tool Cleaning to Bare Metal (SSPC 11) When viewed without magnification, the surface shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the

lower portion of pits if the original surface is pitted. The surface profile shall not be less than 1 mil (25 microns).

9. Surface Preparation of Concrete (SSPC-SP 13/NACE 6): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.07 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. The Shop Painting Facility shall use a minimum blast material mixture of 75 percent grit and 25 percent shot material to achieve the proper surface profile.

C. The Field Coating Applicator shall abrasive blast the shop coated surfaces per SSPC SP 7/NACE 4. The previously shop-painted surfaces shall be abraded prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.

D. Grease, oil, and welding fluxes shall be removed by wiping with MEK or naphtha cleaning or with trisodium phosphate detergent per SSPC SP 1.

E. All sharp edges shall be rounded or chamfered and all burrs, rust, scale, welding slag, and spatter shall be removed and the surface prepared by SSPC SP 2 hand tool cleaning, and SSPC SP 3 power tool cleaning.

F. The CONTRACTOR shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any blasted surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter (µg/cm2). A test shall be conducted for every 100 square feet (ft2) of surface area to be coated at locations determined by the Inspector.

G. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the CONTRACTOR shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate’s surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

H. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-

submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

I. The CONTRACTOR shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

J. Compressed air for air blast cleaning shall be supplied at adequate pressure from well-maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

K. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

L. Enclosed areas and other areas where dust settling is a problem shall be vacuum-cleaned and wiped with a tack cloth.

M. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

N. If the required abrasive blast cleaning will damage adjacent Work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP 2 or SSPC SP 3 may be used.

O. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP 1 before the abrasive blast cleaning has been started.

P. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.

3.08 FERROUS METAL SURFACE PREPARATION (GALVANIZED)

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP 1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system, followed by brush off blast cleaning per SSPC SP 7/NACE 4.

B. Any high spots, sharp protrusions, and rough edges, such as the metal drip line, shall be smoothed to avoid paint film gaps in the areas of the high spots. Surfaces shall be hand tool cleaned per SSPC SP 2 and power tool cleaned per SSPC SP 3.

C. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer. Galvanized metals may be cleaned with suitable organic solvent such as a rust inhibitor or aqueous alkaline solution per ASTM D6386.

D. The surfaces of galvanized steel exposed to chemical splashing or within a wastewater head space shall be abraded per SSPC SP 11 or SP 7 prior to coating.

3.09 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS, EXCLUDING STEEL RESERVOIR INTERIORS

A. General: Grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. Abrasive Blast Cleaning: The CONTRACTOR shall provide the degree of cleaning indicated in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC SP 6/NACE 3. Areas of tightly adhering coatings shall be cleaned to SSPC SP 7/NACE 4, with the remaining thickness of existing coating not to exceed 3-mils.

C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings the CONTRACTOR shall apply intermediate coatings per the manufacturer's recommendation for the indicated coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. Unknown Coatings: Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. Water Abrasive or Wet Abrasive Blast Cleaning: Where indicated or where Site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced equipment with a successful service record. Wet blasting methods shall not be used for submerged or severe service coating systems unless indicated.

3.10 CONCRETE AND CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. Surface preparation shall not begin until at least 30 Days after the concrete or masonry has been placed. All water retaining structures shall be successfully leak tested prior to coating application.

B. At the discretion of the Inspector, the CONTRACTOR shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter (µg/cm2). A test shall be conducted for every 100 square feet

(ft2) of surface area to be coated at locations determined by the Inspector.

C. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the CONTRACTOR shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate's surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

D. In accordance with ASTM D4262, test to determine the pH of the concrete surface after the surface has been thoroughly blasted and cleaned. If the pH is outside the range recommended by the coating manufacturer, then the surface must be neutralized by removing concrete until the surface pH of 7 or greater is obtained prior to any coating application. One pH test shall be performed every 200 square feet, or less, and at locations determined by the Inspector.

E. The CONTRACTOR shall test for capillary moisture in accordance with ASTM D4263. Moisture tests shall be taken every 200 square feet or less and at locations determined by the Inspector. If capillary moisture is present, the coating manufacturer shall be consulted to determine primer requirements and special coating application criteria.

F. For below grade structures with surface areas greater than 2,000 square feet, the CONTRACTOR shall install three anhydrous calcium chloride test kits on bare concrete to measure the Moisture Vapor Transmission Rate (MVTR) on a flat horizontal surface. Testing and calculations shall be performed according to ASTM F1869. The MVTR shall be less than 3 lbs per 1,000 square feet per 24 hours. If the MVTR is greater than 3 lbs per 1,000 square feet per 24 hours, the CONTRACTOR shall apply a concrete sealant to reduce the MVTR through the concrete. The test kits shall be undisturbed for a minimum of 60 hours.

G. Surface Voids: Bugholes, honeycomb, or other surface voids greater than 1/4 inch in depth or 1/4 inch in diameter shall be filled in with a resurfacing mortar prior to the application of any primer or finish coat.

H. Holes or other joint defects in masonry shall be filled with mortar and repainted. All voids and cracks shall be repaired as specified. Loose or spatter mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.

I. Coating Pipe Penetrations: A 1/4-inch wide by 3/8-inch deep saw cut shall be made around the circumference of the pipe as it penetrates the concrete. Prior to the coating application, the saw cut shall be dried and vacuumed to remove all dust and residue.

J. Coating Floor/Wall Joints: A 1/4-inch wide by 3/8-inch deep saw cut shall be made on the vertical and horizontal concrete surfaces around the perimeter of the floor. The saw cut shall be 2 inches from the joint on both sides. Prior to the coating application, the saw cut shall be dried and vacuumed to remove all dust and residue.

K. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC-SP 1 before abrasive blast cleaning.

L. New concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, and deteriorated concrete, and to roughen the surface equivalent to 80 Grit sandpaper or ICRI No. 310.2 Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays Concrete Surface Profile No. 4.

M. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

N. Secondary Containment: Treat cracks, construction joints, expansion joints and inside corners according to the coating manufacturer's recommendations.

3.11 PLASTIC, FIBER GLASS ANAD NON-FERROUS METALS SURFACE PREPARATION

A. Plastic and fiber glass surfaces shall be sanded or brush off blast cleaned prior to solvent cleaning with a chemical compatible with the coating system primer.

B. Non-ferrous metal surfaces shall be solvent-cleaned SSPC SP 1 followed by sanding or brush-off blast cleaning SSPC SP 7/NACE 4.

C. Surfaces shall be clean and dry prior to coating application.

3.12 ARCHITECTURAL CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. The mortar surfaces shall be cured at least 14 Days before surface preparation Work is started.

B. Dust, dirt, grease, and other foreign matter shall be removed prior to abrasive blasting.

C. The masonry surfaces shall be prepared in accordance with the material manufacturer's printed instructions.

3.13 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color.

The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop primer requires top coating within a specific period of time, the equipment shall be finish-coated in the shop and then be touched up after installation.

B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.

C. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP 1 and SP 2. Damaged shop coating shall be cleaned in accordance with SSPC SP 3, Power Tool Cleaning, and recoated with the primer specified.

D. For every 500 square feet, or less, of steel surface blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed. For each test area, the three replica tape thickness values shall be recorded and must be within 10 percent of the coating manufacturer's recommended profile. If the surface profile does not meet the manufacturer's recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the CONTRACTOR shall reblast the affected areas.

E. The interior surfaces of steel water reservoirs, except for Paragraph A surfaces, shall have surface preparation and coating Work performed in the field.

F. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the indicated quality in the field. Such equipment shall be primed and finish-coated in the shop and touched up in the field with the identical material after installation. The CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

G. For certain small pieces of equipment, the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

H. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being top coated or less time if recommended by the coating manufacturer.

I. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

J. The CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

3.14 APPLICATION OF COATING

A. The application of protective coatings to steel substrates shall be in accordance with SSPC PA 1 - Paint Application Specification No. 1.

B. Cleaned surfaces and each coat shall be inspected prior to applying each succeeding coat. The CONTRACTOR shall schedule such inspection with the Engineer in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. CONTRACTOR shall use an independent stripe coat per SSPC PA Guide 11 for these areas. Particular care shall be used to ensure that the specified coverage is secured on the edges and corners of all surfaces.

F. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperatures exceeding the manufacturer's recommended maximum and minimum allowable.

2. Concrete surfaces will be in direct sunlight during application or within 3 hours after application.

3. Dust or smoke laden atmosphere.

4. Damp or humid weather.

5. Substrate or air temperature is less than 5 degrees F above the dew point.

6. Air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

7. Wind conditions are not calm.

I. Dew point shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Unburied steel piping shall be abrasive blast cleaned and primed before installation.

K. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.15 CURING OF COATINGS

A. The CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.16 SHOP AND FIELD INSPECTION AND TESTING

A. General: The CONTRACTOR shall give the ENGINEER a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.

B. Such Work shall be performed only in the presence of the ENGINEER, unless the ENGINEER has granted prior approval to perform such Work in its absence.

C. Inspection by the ENGINEER, or the waiver of inspection of any particular portion of the Work, shall not relieve the CONTRACTOR of its responsibility to perform the Work in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the Engineer to facilitate inspection. Additional illumination shall be furnished on areas to be inspected.

E. Inspection Devices: The CONTRACTOR shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for the Engineer's use while coating is being done, until final acceptance of such coatings. The CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the Engineer.

F. Holiday Testing: The CONTRACTOR shall test for continuity all coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then be retested.

1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.

2. Coatings with thickness of 20-mils or less total DFT: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a non-sudsing type wetting agent, such as Kodak Photo-Flo or equal, shall be added to the water prior to wetting the detector sponge.

G. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC Paint Application Specification No. 2 using a magnetic type dry film thickness gauge such as Mikrotest Model FM, Elcometer Model 111/1EZ, or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

H. Surface Preparation: Confirm proper surface profile with Testex Press-O-Film replica tape in accordance with NACE RP0287-02.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Plastic and metal signs for building and site use.

1.02 RELATED REQUIREMENTS

A. Section 06100 - Rough Carpentry: Wood blocking and shims.

B. Section 07468 – Metal Siding: Wall siding onto which signs are installed.

C. Section 08110 Steel Doors and Frames: Doors to which signs are installed.

D. Section 09260 – Gypsum Board Assemblies: Wall construction onto which signs are installed.

E. Section 13120 – Metal Building Systems: Wall framing supporting siding to which signage is installed.

1.03 NOT USED

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Product data.

B. Shop drawings: Include lists of sign types, sizes, text, and colors; mounting details; locations; and cast metal plaque rubbings and templates.

C. Samples: Include actual materials.

D. Manufacturer's installation instructions.

E. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

1) Certify recycled material content for recycled content products.

b. Indoor Air Quality Certificates:

1) Certify volatile organic compound content for each interior adhesive and sealant and related primer.

1.07 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed products for minimum 5 years with satisfactory performance record of minimum 5 years.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 10 projects of similar scope as Project with satisfactory performance record.

C. Regulatory requirements: Provide signage in accordance with Americans with Disabilities Act as published in the Federal Register, Volume 56, No. 144, Friday, July 26, 1991.

1.08 CASH ALLOWANCES

A. Section 01020 - Allowances: Requirements governing allowances.

B. Costs Included in Cash Allowances: Cost of product to Contractor or Subcontractor, less applicable trade discounts; delivery to Site and applicable taxes unless stated otherwise in Allowance Schedule.

C. Costs Not Included in Cash Allowances but Included in Contract Sum/Price: Product handling at Site including unloading, uncrating, and storage; protection of products from elements and from damage; and labor for installation and finishing unless stated otherwise in Allowance Schedule.

D. Architect/Engineer Responsibilities:

1. Consult with Contractor for consideration and selection of products.

2. Select products in consultation with Owner and transmit decision to Contractor.

3. Prepare Change Order.

E. Contractor Responsibilities:

1. Assist Architect/Engineer in selection of products and suppliers.

2. Obtain proposals from suppliers and offer recommendations.

3. Upon notification of selection by Architect/Engineer and Owner, execute purchase agreement with designated supplier.

4. Arrange for and process Shop Drawings, Product Data, and Samples. Arrange for delivery.

5. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.

F. Differences in costs will be adjusted by Change Order.

G. Allowance Schedule:

1. Include the stipulated sum of $500 for purchase and delivery of 15 additional metal safety signs as described in this specification with text to be decided during construction. Installation costs are included in Contract Sum/Price and not in allowance

PART 2 - PRODUCTS

2.01 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

C. Indoor Environmental Quality Characteristics:

1. Interior Adhesives: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

2.02 PLASTIC SIGNAGE SYSTEM

A. Manufacturers:

1. One of the following or equal:

a. Best Manufacturing Sign Systems, Montrose, CO; System 900013.

b. APCO Graphics, Atlanta, GA; equivalent product.

c. Vomar Products, Inc., Sepulveda, CA; equivalent product.

B. Attachment:

1. Vinyl tape, self-adhering.

C. Lettering:

1. Helvetica medium, 3/4 inches high.

D. Material for interior use:

1. Plastic 1/8-inch thick raised letters.

E. Material for exterior use:

1. Fiberglass 1/4 inch thick with high gloss finish, raised letters, blasted from single piece of fiberglass for integral letter and background.

2. No adhesive as mechanical fastening of letters shall be allowed.

F. Colors:

1. As selected by Engineer from manufacturer's standard colors.

G. See Schedule A for specific sign size, location, text, pictogram, and quantity.

2.03 METAL SAFETY SIGNS

A. Manufacturer: Meeting OSHA Requirements; 40-mil thick aluminum with baked enamel finish. One of the following or equal:

1. Seton Name Plate Co., Branford, Connecticut, Special Wording.

2. Emedco, Buffalo, New York.

B. Notice information signs:

1. Background: White.

2. Heading: White lettering on blue rectangular panel.

3. Message: Black lettering.

4. Size: As scheduled.

C. Fasteners: Round head stainless steel bolts or screws.

D. See Schedule B for specific sign size, location, text, and quantity.

2.04 CAST ALUMINUM LETTERS

A. Manufacturers:

1. One of the following or equal:

a. Gemini, Cannon Falls, MN.

b. Southwell Company, Corpus Christi, TX.

c. OMC Industries, Bryan, TX.

B. Material:

1. Cast aluminum.

C. Text size and font:

1. As indicated on the Drawings.

D. Finish:

1. Black duranodic coating.

E. Mounting:

1. Projected jamb nut mounting, concealed.

F. See Schedule C for specific size, location, text and quantity.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect adjacent surfaces which may be damaged by installation of signs.

B. Prepare substrates in accordance with sign manufacturer's instructions.

C. Remove scale, dirt, grease, and other contaminates from substrates.

3.02 INSTALLATION

A. Install signs in accordance with sign manufacturer's instructions.

B. Fasten signs securely in level, plumb, and true to plane positions.

C. Install signs where indicated on the Drawings or as indicated in the following schedules.

3.03 SCHEDULES

A. Plastic Signage System Schedule.

B. Metal Safety Sign Schedule.

C. Cast Aluminum System Schedule.

SCHEDULE A

PLASTIC SIGNAGE SYSTEM SCHEDULE

A. Room Numbers:
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
      1) At door D05-1005 (in room 05-101).
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square, unless shown otherwise on the Drawings.
   4. Colors: As selected by the Engineer.
   5. Text: Room number as indicated on the Drawings.

B. Room Numbers & Names:
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
      1) At doors: D05-1001, D05-1005 (in room 05-100), D05-1006, D05-1011, D05-1021, D05-1022, D05-1031.
   2. Height: 60 inches above floor to center or sign.
   3. Size: 6 inches square, unless shown otherwise on the Drawings.
   4. Colors: As selected by Engineer.
   5. Text: Sign per door describing room function as indicated on the Drawings.

C. Fire Extinguishers:
   1. Location: Mounted above all fire extinguishers.
      1) Six signs.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square, unless shown otherwise on the Drawings.
   4. Colors: White letters on OSHA Red background.

D. Non-Potable Water:
   1. Location: Above sink in 05-101 Sample Station.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 10 inches square, unless shown otherwise on the Drawings.
   4. Colors: White letters on OSHA Red background.
   5. Text: NON-POTABLE WATER – DO NOT DRINK NO BEBE EL AGUA.

END OF SCHEDULE A
PLASTIC SIGNAGE SYSTEM SCHEDULE

SCHEDULE B

METAL SAFETY SIGN SCHEDULE

A. STORAGE NOTICE:
   1. Location: On interior side of door.
   2. Height: 60 inches.
   3. Size: 14 inches wide by 10 inches high.
   4. Number: 5 signs total.
   5. Heading: NOTICE
   6. Wording: BY ORDER OF THE AUSTIN FIRE DEPARTMENT THIS ROOM SHALL NOT BE USED FOR STORAGE OF ANY KIND OR FOR ANY DURATION

B. NO SMOKING INFORMATIONAL SIGNS:
   1. Location: On exterior face of wall, adjacent to each entry point (exterior door) to building.
   2. Height: 60 inches above floor to center of sign. Where metal safety signs are also located adjacent to entry points, place no smoking signs below these signs.
   3. Size: 6 inches square.
   4. Number: 9 signs total.
   5. Heading: None.
   6. Wording: None.
   7. Pictogram: International "No Smoking" symbol.

C. ACCESSIBLE PARKING SIGN (POST MOUNTED AND REFLECTORIZED):
   1. Location: Centered on the parking space reserved for persons with disabilities in accordance with UBC 1129B5.
   2. Height: 60 inches from the bottom of sign to parking space finished grade, in accordance with UBC 1129B5.
   3. Size: Not smaller than 70 square inches.
   4. Number: 1 sign total.
   5. Wording: As required to suit local regulations.
   6. Pictogram: Symbol of accessibility in white on dark blue. Include Van Accessible text.

END OF SCHEDULE B
METAL SAFETY SIGN SCHEDULE

SCHEDULE C

CAST ALUMINUM LETTERS SCHEDULE

A. BUILDING SIGN:
   1. Location: On North side of Blower Building, mounted to Building, 13 feet AFF.
   2. Letter Height: 8 inches.
   3. Text: AMMONIA REMOVAL FACILITY – BLOWER BUILDING

END OF SECTION 10400

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire extinguishers.

2. Fire extinguisher cabinets.

1.02 RELATED REQUIREMENTS

A. Section 06100 - Rough Carpentry: Wood blocking and shims.

B. Section 07468 Metal Siding: Wall finish to accept brackets.

C. Section 09260 – Gypsum Board Assemblies: Wall construction to accept brackets.

D. Section 10400 – Signage: Identifying signs mounted adjacent to extinguishers.

E. Section 13120 – Metal Building Systems: Building framing to which extinguishers are installed.

1.03 REFERENCE STANDARDS

A. ASTM International:

1. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

B. National Fire Protection Association:

1. NFPA 10 - Standard for Portable Fire Extinguishers.

C. UL:

1. UL - Fire Protection Equipment Directory.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Section 01300 - Submittals: Requirements for submittals.

B. Product Data: Submit extinguisher classifications, operational features, color and finish, anchorage details.

C. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

a. Materials Resources Certificates:

1) Certify source and origin for products.

2) Certify recycled material content for recycled content products.

3. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

D. CLOSEOUT SUBMITTALS

1. Section 01700 – Contract Closeout: Requirements for closeout procedures.

2. Operation and Maintenance Data:

a. Submit test, refill, or recharge schedules.

b. Submit recertification requirements.

1.07 DEFINITIONS

A. ADA: Americans with Disabilities Act.

1.08 QUALITY ASSURANCE

A. Comply with NFPA 10.

B. Provide extinguishers classified and labeled by UL for indicated purposes.

C. classified and labeled by UL for indicated purpose.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 – Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site and inspect for damage.

C. Store and protect materials according to manufacturer's instructions.

1.10 AMBIENT CONDITIONS

A. Section 01500 - Temporary Facilities: Requirements for ambient condition control facilities for product storage and installation.

B. Do not install extinguishers when ambient temperature is capable of freezing extinguisher contents.

1.11 NOT USED

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguisher: One of the following or equal:

1. J.L. Industries, Bloomington, MN.

2. Larsen's Manufacturing Company, Minneapolis, MN.

3. Modern Metal Products by Muckle, Owatonna, MN.

2.02 FIRE EXTINGUISHERS

A. Type FE05: UL 2A:10B:C with 5-pound capacity of dry chemical with ammonium phosphate base for extinguishing ABC fires.

B. Type FE10: UL 4A:60B:C with 10-pound capacity of dry chemical with ammonium phosphate base for extinguishing ABC fires.

C. Type FE20: UL 20A:120B:C with 20-pound capacity of dry chemical with ammonium phosphate base for extinguishing ABC fires.

D. Type EFE10: UL 1A:10B:C with 10-pound capacity of colorless, odorless, electrically non-conductive liquefied gas, or clean agent as defined by NFPA 2001, for extinguishing electrical fires without leaving residue.

E. Type EFE15: UL 2A:10B:C with 15-pound capacity of colorless, odorless, electrically non-conductive liquefied gas, or clean agent as defined by NFPA 2001, for extinguishing electrical fires without leaving residue.

2.03 WALL BRACKETS

A. Type: Standard as manufactured by fire extinguisher Manufacturer

2.04 FIRE EXTINGUISHER CABINETS

A. Manufacturers: One of the following or equal:

1. J. L. Industries: Model 1816G10.

2. Larsens Manufacturing Company: Model 2409-5R.

3. Fire-End & Croker Corporation: Model 1601-A.

B. Cabinets: Semi-recessed as indicated; stainless steel at wet areas, steel elsewhere:

1. Tub:

a. Trim: Recessed, 1-1/4 inch face trim.

b. Material: Cold-rolled steel.

c. Finish: Semi-gloss epoxy, white.

C. Door:

1. Type: Clear Vu Series.

2. Style: Full acrylic.

3. Glazing: Clear bubble, 1/8 inch thick.

4. Stiles and Rails: 1 inch wide.

5. Metal Material: Same as for tub.

6. Metal Finish: Same as for tub.

7. Pull: MANUFACTURER'S standard.

8. Catch: Self-adjusting roller type.

2.05 OPERATING HARDWARE

A. Hinges: Continuous heavy duty hinge.

2.06 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

2.07 ACCESSORIES

A. Extinguisher Brackets: Formed steel, corrosion resistant finish, size and type to suit extinguisher.

B. Fasteners: Fasteners exposed in the final installation, with the door open and closed, shall be tamper-proof fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with Manufacturer's recommendations.

B. Install products plumb, square and level.

C. Place Extinguishers: Locate 1 extinguisher in each cabinet and elsewhere as indicated.

3.02 SCHEDULE

A. Install fire extinguisher on brackets and in cabinets where indicated in the Drawings.

B. Install extra fire extinguishers with brackets where directed by the Engineer.

3.03 FIRE EXTINGUISHER SIZE AND PLACEMENT CRITERIA (PER NFPA 10)

For Class A Hazards			
	Light Hazard Occupancy	**Ordinary Hazard Occupancy**	**Extra Hazard Occupancy**
Minimum Rated Single Extinguisher	2-A	2-A	4-A
Maximum floor area per unit A	3,000 sq. ft.	1,500 sq. ft.	1,000 sq. ft.
Maximum floor area for extinguisher	11,250 sq. ft.	11,250 sq. ft.	11,250 sq. ft.
Maximum travel Distance to extinguisher	75 feet	75 feet	75 feet

For Class B Hazards		
Type of Hazard	**Minimum Extinguisher Rating**	**Maximum Travel Distance to Extinguisher (feet)**
Light (Low)	5-B 10-B	30 50
Ordinary (Moderate)	10-B 20-B	30 50
Extra (High)	40-B 80-B	30 50

For Class C Hazards

Class C ratings are required where energized electrical equipment is encountered. Since fire itself is a class A or B hazard, the extinguishers are sized and located on the Basis of the Class A or B hazard.

Installation of Fire Extinguishers

Extinguishers must be installed on the hangers or in the brackets supplied, mounted in cabinets, or set on shelves, except when the extinguishers are the wheeled type.
Extinguishers having a gross weight up to 40 pounds shall be installed so the top of the extinguisher is not more than 5 feet above the floor.
Extinguisher having a gross weight of more than 40 pounds shall be installed so that the top of the extinguisher is not more than 3'-6" above the floor.

END OF SECTION 10520

PART I - GENERAL

1.01 SUMMARY

A. The provisions of this Section shall apply to all equipment throughout the Contract except where otherwise indicated. The Contractor shall provide equipment and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. The equipment Arrangement: Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available from manufacturers at the time of design and it is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic, and some features of the illustrated equipment arrangement may require revision by the Contractor to meet the actual equipment requirements proposed by the Contractor. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered by the Contractor to accommodate the equipment provided. No additional payment will be made to the Contractor for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the fabrication of equipment.

C. Unit Responsibility:

1. The Contractor shall furnish, coordinate, assemble, install, and test the system as an operating unit. Unless otherwise specified:

2. The Contractor shall furnish, coordinate equipment selection with the manufacturer of the driven equipment to insure compatibility. The manufacturer shall assure selected components of the system are checked for compatibility, ease of construction, and efficient operation and maintenance. The manufacturer shall ensure coordination of design of all system components such that all equipment furnished under the specifications for the equipment system, including equipment specified elsewhere but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Agents, representatives, or other entities who are not a direct component of the manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in meeting this requirement.

3. This requirement for unit responsibility shall in no way relieve the Contractor of responsibility for meeting the overall performance of equipment as specified in the Contract Provisions.

4. The Contractor shall assure that all equipment systems provided for the project are products for which unit responsibility has been coordinated by the responsible party.

5. Where the specification requires a Certificate of Unit Responsibility, submit a statement signed by an officer of the manufacturer's corporation, and certified by the Contractor that the equipment have been designed, selected and coordinated are compatible with the overall integrated system as specified.

6. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory.

D. Single Manufacturer: Where two or more pieces of equipment of the same type or same size are required, the equipment shall be produced by the same Manufacturer.

E. Protection During Shipment and Storage

1. General: Unless otherwise specified in the specific Section for the equipment, this paragraph applies.

2. Shipping:

a. Equipment: Ship in sealed, weather-tight enclosed containers with silica gel desiccants to protect equipment from moisture and corrosion during shipment. Equipment shall be properly and protected against from being damaged or stresses during transport to the job site.

b. Bearing housings: Protect anti-friction bearings from being damaged in transit due to moisture and contaminants. Shafts locked to equipment housing to prevent bearing damage during shipment.

3. Damage: Correct to conform to the Contract requirements before the assembly is incorporated into the work.

4. Factory applied coatings: Each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied prime coating.

5. Special monitoring: For the equipment listed below, a recording accelerometer, designed to record the magnitude of sudden impacts in 3 directions (X, Y, Z) on continuous strip charts with both time and "g" force scales, shall be shipped with, and fixed to each separately packed assembly or its packing crate. The units shall be shipped with a backup accelerometer and with new batteries. Upon arrival of each shipment, immediately notify the Project Representative; the accelerometer: shall be removed in the presence of representatives of the Project Representative and the Contractor. If the magnitude of the maximum acceleration exceeds 3.0 g, the assembly and any subassembly shall be dismantled and inspected for damage.

6. The following list of equipment shall be monitored during shipment:

    a. All electric motors and pumps 500 hp and larger or pump with a rated capacity of 10,000 gpm or larger.

    b. All blowers, compressors with motors 500 hp and larger.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
05500	Metal Fabrications
09960	High-Performance Coating
11100	Pumps General
15001	Piping General
15006	Hangers and Supports for Process Piping

1.03 REFERENCES

A. Reference Standards

American Bearing Manufacturers Association (ABMA)	
American Gear Manufacturers Association (AGMA)	
American National Standards Institute (ANSI)	
ANSI B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)	
American Society of Mechanical Engineers (ASME)	
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ASME B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and other Special Alloys
ASME B46.1	Surface Texture
ASME B1.20.1	General Purpose Pipe Threads (Inch)
ASME B31.1	Power Piping
ASME B31.3	Process Piping

American Water Works Association (AWWA)	
AWWA M11	Steel Pipe – A Guide for Design and Installation
AWWA C206	Field Welding of Steel Water Piping
AWWA C207	Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Steel Tanks for Water Storage
American Welding Society (AWS)	
American Society for Testing and Materials (ASTM)	
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality
Federal Specifications (FS)	
Hydraulic Institute (HI)	
Mechanical Power Transmission Association (MPTA)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 820 Standard for Protection in Wastewater Treatment and Collection Facilities	
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects
Occupational Safety and Health Administration (OSHA).	
Underwriters Laboratories (UL)	
Rubber Manufacturers Association (RMA)	

1.04 SUBMITTALS

A. Product Data

1. Submit product data consisting of manufacturer's printed data sheet or catalog cuts illustrating product information required to demonstrate that the equipment meet project section subject to review by the Engineer.

B. Shop Drawings Submittals

1. Furnish submittals in accordance with Section 01300 – Submittals.

2. Shop Drawings: Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the Engineer, Shop Drawings shall include clear, concise

calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the Contractor.

3. Spare Parts List: The Contractor shall obtain from the manufacturer and submit as part of Shop Drawings a list of specified and recommended spare parts for each piece of equipment. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.

1.05 QUALITY ASSURANCE

A. Costs: Responsibility shall be by the Contractor's for performing and paying the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives. The Owner will pay for costs of power and water. If available, the Owner's operating personnel will provide assistance in the field testing.

B. Inspection: The Contractor shall inform the local authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, cranes, and related items to obtain required permits and certificates, and shall pay inspection fees.

C. Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

D. Machine Work shall be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members or machine parts without machined or milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.

E. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The Engineer shall be notified of larger defects. No repair welding of such defects shall be carried out without the Engineer's written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress, then the casting may be rejected. Costs of casting new material shall be the Contractor's responsibility as part of the Work.

F. Materials shall meet the physical, chemical, metallurgical and mechanical properties in accordance with the reference standards. All materials or products shall be new and from a Manufacturer specializing in the manufacture of the product. All materials shall be high-grade, standard

commercial quality, free from all defects and imperfection, and shall be recommended by the Manufacturer for the intended application.

G. Machine Finish: The type of finish shall be the most suitable for the application as recommended by the equipment manufacturer in micro-inches in accordance with ANSI B46.1 Surface Texture (Roughness, Waviness, Lay). In the absence of manufacturer's recommendations, the following surface finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

H. Manufacturer's Experience: Equipment manufacturer shall have a record of proven experience of at least 5 years of successful, trouble-free operation in similar applications, type, model and size equal or larger than the equipment specified in this Contract. Where indicated in each individual equipment specifications, the Contractor shall submit this experience record to the Engineer for approval.

PART II - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Noise Level: When the equipment is in operation, no equipment shall exceed the following OSHA permissible noise exposure levels per day; 105 dBA for one hour, 100 dBA for two hours or 90 dBA for eight hours.

B. High Noise Level Location: The Contractor shall provide one personal hearing protection station at each location defined as follows:

1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise permissible level for a 2-hour exposure. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, the area for each group of equipment shall be provided with a separate hearing protection station.

2. Indoor Location

a. Any single equipment item or any group of equipment items located within a single room not normally occupied, that produces

noise exceeding OSHA noise permissible level for a 2-hour exposure.

b. Any single equipment item or any group of equipment items located within a single room normally occupied by workers that produces noise exceeding OSHA noise permissible level for an 8-hour exposure.

C. Personal Hearing Protection: The Contractor shall furnish 3 pairs of high attenuation hearing protectors in the original unopened packaging. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, provided at an approved location near the noise producing equipment.

D. Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque (whichever is the greatest), speed, and horsepower. Applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, and temperature. Drive train components include couplings, shafts, gears, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	**Service Factor**	**Load Classification**
Blowers		
centrifugal or vane	1.0	Uniform
lobe	1.25	Moderate Shock
Pumps		
centrifugal or rotary	1.0	Uniform
reciprocating	1.8	Moderate Shock
progressing cavity	1.0	Uniform
Mixers		
constant density	1.0	Uniform
variable density	1.25	Moderate Shock
rapid mixer	1.25	Moderate Shock
sludge mixer	2.5	Moderate Shock

E. Mechanical Service Factors

	Mechanical Service Factors	
	Electric Motor	**Internal Combustion Engine**
Uniform	1.25	1.50
Moderate Shock	1.50	1.75
Heavy Shock	2.00	2.25

F. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to the manufacturer sizing information.

G. Where load classifications are not indicated, the equipment manufacturer's recommendations for service factors shall be utilized.

H. Welding: Unless otherwise indicated, welding shall conform to the following:

1. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

2. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a smooth and acceptable appearance with uniform weld contours and dimensions. Sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent corrosion of hard-to-coat metallic surfaces.

4. Welded steel tanks: Latest revision of AWWA D100.

5. Welded steel piping: Latest revision of AWWA C206.

I. Protective Coating: Equipment shall be painted or coated in accordance with Section 09960 – High-Performance Coatings, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

J. Potable Water Contact: Materials immersed in or exposed to potable water shall be made of materials or coated compliant with NSF/ANSI 61. Bronze alloy materials in contact with potable water shall be constructed of zero-

lead materials or materials whose lead content do not exceed the weighted average criteria as required by the Lead Reduction Act. Equipment manufacturer shall submit to the Engineer a certification of compliance with the requirement of NSF Standard 61 and the Lead Reduction Act.

K. Protection of Equipment: Machined and coated surfaces shall be protected by rust inhibitor material prior to shipment. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Equipment with anti-friction bearings or sleeve bearings shall be protected from being damaged due to jarring motion during shipment. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized, and shafts shall be rotated per manufacturer's recommendation. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, recoated, or otherwise corrected to restore it to original condition.

L. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given permanent identification.

    a. Pumps, compressors, and blowers of 150 horsepower or less shall receive acrylic plastic or stainless steel plate nametags.

    b. Pumps, compressors, and blowers larger than 150 horsepower shall receive stainless steel plate nametags.

M. Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

N. Equipment Maximum Allowable Vibration Level: Unless otherwise indicated, maximum allowable vibration level shall be in accordance with the acceptance criteria recommended by the reference Standard for that particular type of equipment

O. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.

P. Controls: Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

2.02 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Equipment components and supports, anchors, and seismic restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greatest of the following design criteria:

B. Submit design calculations for equipment supports, anchors, and seismic restrainers signed and sealed by an engineer registered in the State wherein the project is to be built. Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, and normal operation plus wind loadings.

1. Wall-mounted equipment weighing more than 250 pounds, or which is within 18-inches above the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

2. Seismic requirements: Freestanding and wall-hung equipment shall be anchored in place by methods. Calculations shall be performed and signed and stamped for equipment weighing more than 400 pounds. Calculations shall analyze lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

3. Wind requirements: Exterior freestanding equipment shall be anchored in place by methods. Calculations shall be performed and signed and stamped, analyzing lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

4. Anchors: Anchor bolts shall be in accordance with Section 05500 – Metal Fabrications. Contractor shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the Shop Drawings.

5. Equipment Grout: Mechanical equipment installed on top of concrete foundations or bases shall be provided with non-shrink concrete or epoxy grout as indicated. Grout shall be applied between the base

plate and the concrete foundation or base in accordance with the grout manufacturer's recommendation. Grout shall be free of void space.

2.03 COUPLINGS

A. Mechanical couplings shall be provided between the driver and the driven equipment. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Unless otherwise indicated or recommended by the equipment manufacturer, coupling type shall be furnished with the respective equipment as follows:

Equipment Type	**Coupling Type**
Horizontal and end suction pumps	Gear or flexible spring
Single stage centrifugal blowers	Flexible disc pack

B. Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, 2 sets of flexible disc pack couplings or as recommended by equipment manufacturer shall be provided.

D. Taper-Lock or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

2.04 SHAFTING

A. General: Equipment manufacturer shall be responsible for designing and manufacturing shafting to carry all loads applied to the shaft. Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Design Criteria: Shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications.

C. Materials: Shafting materials shall be compatible with the type of service and load transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.

1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.

2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.

3. Other grades of carbon steel alloys shall be suitable for service and load.

4. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

2.05 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the Engineer.

B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather with humidity control filter to allow air to escape but keep moisture, dust and dirt out. The casing shall be of cast iron, ductile iron, or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be selected by the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with required appurtenances shall be provided when necessary.

F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the Contractor shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

2.06 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains meeting ASME Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

2.07 SPROCKETS

A. General: Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. Materials: Unless otherwise indicated, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.

2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.

3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. Sprockets shall be accurately machined to ASME Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with key seat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with Taper-Lock bushings as required.

F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.08 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ASME, MPTA, and RMA Standards.

B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.

C. Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be provided complete with Taper-Lock or QD bushings as required.

E. Finish bored sheaves shall be complete with key seat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.09 DRIVE GUARDS

A. Power transmission trains, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform to the OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10-gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication, and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.10 BEARINGS

A. General: All bearings shall be selected and sized by the equipment manufacturers and reviewed by bearing manufacturers. Bearing life calculation shall be submitted and reviewed by bearing manufacturer. Bearing shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).

B. To assure satisfactory bearing application, ambient temperature, humidity, internal clearances, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. Anti-Friction Type Bearing Life: Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	**Design Life, years**	**L-10 Design Life, hours**
	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing manufacturer.

H. Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, manufacturer shall provide heat exchangers, incluging necessary intrumentation and controls, piping, filters, and valves.

2.11 PIPING CONNECTIONS

A. Pipe Hangers, Supports, and Guides: Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 15006 – Hangers and Supports for Process Piping.

B. Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 15001 – Piping General.

C. Flexible Connectors: Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of Section 15001 – Piping General. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

D. Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the specifications.

2.12 GASKETS AND PACKINGS

A. Gaskets and packings shall be in accordance with the requirements of the specifications. Gaskets and packings in contact with drinking water shall be NSF 61 approved. Elastomeric materials in contact with water with chloramines, or water with ozone residual shall be made of Teflon or Viton-A, or equal.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane Everseal, or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O" rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the Engineer, in accordance with Section 11100 - Pumps General.

2.13 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.14 SPECIAL TOOLS AND SPARE PARTS

A. Tools: The Contractor shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

B. Spare parts shall be furnished as indicated in the individual equipment sections. Spare parts shall be suitably packaged in a metal box and labeled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.15 EQUIPMENT LUBRICANTS

A. The Contractor shall provide lubricants for equipment during shipping, storage, and prior to testing, in accordance with the manufacturer's recommendations. Lubricants that could come in contact with potable water shall be food grade lubricants. After successful initial testing, final testing, and satisfactory completion startup testing, the Contractor shall conduct one complete lubricant change on equipment. In addition, the Contractor shall be responsible for the proper disposal of used lubricants. The Owner will then be responsible for subsequent lubricant changes.

PART III - EXECUTION

3.01 SERVICES OF MANUFACTURER

A. Installation Supervision, Inspection, Startup, and Field Adjustment: An authorized, experienced, and competent service representative of the manufacturer shall visit the Site to perform the following:

1. Supervision of the installation of the equipment.

2. Inspection, checking, and adjusting the equipment and approving its installation.

3. Startup and field testing for proper operation, efficiency, and capacity.

4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements.

5. Verify, affirm and certify that the specified equipment performance acceptance criteria and conditions such as temperature and vibration amplitude, have been meet. Submit test certificate signed by the Contractor and witnessed by the Engineer representative.

6. Certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

7. Unless otherwise indicated, factory representative shall be present at the job site for the following number of days each trip:

   a. Half a day per equipment for smaller than 500 horsepower.

   b. One day per equipment for 500 horsepower and larger.

B. Owner Staff Training

1. An authorized training representative of the Manufacturer shall visit the site for a number of days indicated in those sections to instruct the Owner's personnel in the operation and maintenance of the equipment, including step by step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least two years' experience in training. A resume of the representative shall be submitted.

3. Unless otherwise specified, a minimum of two separate day trips shall be provided for each type of equipment, with one day of training included in each trip.

3.02 INSTALLATION

A. General: Equipment shall be installed in accordance with the manufacturer's written recommendations and approved shop drawings.

B. Alignment: Equipment shall be field tested to verify proper alignment.

3.03 TESTING

A. General requirements

1. All mechanical equipment shall undergo factory and field performance and functional test to demonstrate that the process equipment system meet the requirement of the Contract Document. Detailed testing requirement are specified in each equipment specification sections.

2. Unless otherwise specified, equipment factory testing procedure shall follow the Industry Standard test procedure that applies to that equipment.

3. Submit test procedures for review by the engineer one month prior to the scheduled test.

B. Test sequence

1. Factory functional and performance testing

2. Component tests

3. System tests

4. Individual system or train test

5. Overall facility operational tests

3.04 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.

B. If the packaged system has any additional features (such as safety interlocks, etc.) other than required by the Contract Documents, the Contractor shall coordinate such features with the Engineer and provide material and labor necessary for a complete installation as required by the manufacturer.

3.05 FIELD ASSEMBLY

A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with Never Seize compound or equal.

3.06 FIELD TESTS

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.

B. The following field testing shall be conducted:

1. Operational Readiness Tests (ORT)

    a. Check equipment for proper installation, baseplates leveled, grouted and anchor bolts properly torqued to manufacturer's specifications and rotating assemblies balanced and shafts aligned.

    b. Install all instruments and their associated components, controls panels, wirings are installed, calibrated and termination checked.

    c. Install and check all PLC's, Input/output wires and all terminations.

    d. Install all power cables from MCC to motors and checked.

2. Perform trial operation. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.

3. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

C. The Engineer shall witness field-testing. The Contractor shall notify the Engineer of the test schedule 3 Days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Provide pumps and pump systems appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.

C. Unit Responsibility

1. The pump manufacturer shall be made responsible for furnishing the pumps and drives; motors, engines, gears and Variable Frequency Drives (VFDs) as one package and for the coordination of design, assembly, testing, installation, and startup of the Work of each specific pump Section.

2. The Contractor shall be responsible to the Owner for compliance with the requirements of each specific pump Section.

D. Single Manufacturer

1. Where 2 or more pump systems of the same type or size are required, provide pumps produced by the same pump manufacturer.

2. Where multiple pumps are of the same size and type, all parts shall be interchangeable and fit including spare parts.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
05500	Metal Fabrication
09960	High-Performance Coatings
11000	Equipment General
15001	Piping General
Division 16	Electrical
Division 17	Instrumentation and Control

1.03 REFERENCES

A. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM A 36	Medium Carbon Steel for fabricated steel bases
ASTM A 48	Gray Iron Castings
ASTM B 148	Standard Specification for Aluminum-Bronze Sand Castings
ASTM A 276	Hot Rolled Annealed and Pickled Stainless Steel Shafts
ASTM A569/AISI 1018, 1020	Low Carbon Steel Shaft
ASTM A569/AISI 1045	Medium Carbon Steel Shaft
ASTM A705	Age-Hardening Stainless Steel Forgings
ASTM B148	Aluminum Bronze Sand Castings
ASTM B140	Copper-Zinc-Lead (Red Brass or Hardware Bronze)
ASTM B 584	Standard Specification for Copper Alloy Sand Castings for General Applications
International Organization for Standardization (ISO)	
ISO 9000	Quality management systems - Fundamentals and Vocabulary
ISO 9001	Quality management systems – Requirements.
ISO 1940-1	Mechanical Vibration – Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
American National Standards Institute /Hydraulic Institute (ANSI/HI)	
ANSI/HI 3.1- 3.5	Rotary Pumps for Nomenclature, Definitions, Application and Operation
ANSI/HI 3.6	Rotary Pump Tests
ANSI/HI 4.1- 4.6	Sealless, Magnetically Driven Rotary Pumps for

	Nomenclature, Definitions, Application, Operation, and Test
ANSI/HI 5.1- 5.6	Sealless, Rotodynamic Pumps for Nomenclature, Definitions, Application, Operation, and Test
ANSI/HI 6.1-6.5	Reciprocating Power Pumps for Nomenclature, Definitions, Application, and Operation
ANSI/HI 6.6	Reciprocating Pump Tests
ANSI/HI 9.1 – 9.5	Pumps General Guidelines
ANSI/HI 9.6.1	Rotodynamic Pumps – Guideline for NPSH
ANSI/HI 9.6.2	Rotodynamic Pumps for Assessment of Applied Nozzle Loads
ANSI/HI 9.6.3	Rotodynamic Pumps – Guidelines for Operation Regions
ANSI/HI 9.6.4	Rotodynamic Pumps - Guidelines for Vibration Measurements and Allowable Values
ANSI/HI 9.6.6	Rotodynamic Pumps - Guidelines for Pump Piping
ANSI/HI 9.6.8	Rotodynamic Pumps – Guidelines for Dynamics of Pumping Machinery
ANSI/HI 9.8	Rotodynamic Pumps for Pump Intake Design
ANSI/HI 11.6	Rotodynamic Submersible Pumps for Mechanical and Electrical Acceptance Criteria
ANSI/HI 14.1-14.2	Rotodynamic Pumps for Nomenclature and Definitions
ANSI/HI 14.3	Rotodynamic Pumps for Design and Application
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Test
ANSI/HI 40.6	Methods for Rotodynamic Pump Efficiency Testing
National Sanitation Foundation/American National Standards Institute (NSF)	
NSF/ANSI 61 -	Drinking Water System Components – Health Effects

1.04 SUBMITTALS

A. Product Data

1. Furnish submittals in accordance with the requirements of Section 01300 – Submittals.

B. Shop Drawings

1. Submit pump name, identification number, and specification Section number.

2. Performance Information

   a. Submit performance data curves showing head, capacity, horsepower demand, NPSHr required, and pump efficiency over the entire operating range of the pump.

   b. Require the equipment manufacturer to indicate the head, capacity, required horsepower, pump efficiency, and NPSHr corresponding to each flow condition indicated in the respective performance requirement paragraph of each individual pump specification section. Indicate in the pump curve minimum submergence required at maximum flow for vertical and submersible pumps.

   c. Submit performance curves at intervals no greater than 100 RPM from minimum speed to maximum speed for each centrifugal pump equipped with a variable speed drive.

3. Operating Range

   a. Require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. Indicate on the pump performance curve the limits of the Preferred Operating Region (POR) and the Allowable Operating Region (AOR).

4. Submit assembly and installation drawings, including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

5. Submit electric motor data in accordance with the requirements of Section 16220 –Motors, for the electric motor proposed for each pump.

6. Submit an elevation drawing of the proposed local control panel, showing panel-mounted devices, details of enclosure type, a single-line diagram of power distribution, current draw of the panel, and a list of all terminals required to receive inputs or to transmit outputs from the local control panel.

7. Submit a wiring diagram of field connections, with identification of terminations between local control panels, junction terminal boxes, and equipment items.

8. Submit a complete electrical schematic diagram.

C. Spare Parts List

1. Submit a spare parts list containing the required information indicated in Section 01300 – Submittals and each specific pump Section.

D. Factory Test Data

1. Pumps that shall be factory witness tested. Submit layout drawing of factory test setup showing the pump, drive, piping diameter and lengths, locations of valves, instruments and test procedures and valid calibration certificates of test instruments.

2. Submit signed, dated, and certified factory test data for each pump system. No equipment shall be shipped until the test data have been approved by the Engineer.

E. Certifications

1. Submit the manufacturer's certification of proper installation.

2. Submit the Contractor's certification of satisfactory field testing.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery and Acceptance Requirements

1. The Equipment shall be shipped and stored on site until time of installation per manufacturer's requirements

2. Any corrosion in evidence or damage to the coatings shall be repaired to the satisfaction of the Engineer.

PART II - PRODUCTS

2.01 GENERAL

A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Performance / Design Criteria

1. Capacities

a. Provide pumps with a continuously rising pump curve, or with a pump curve that does not cross the system curve within the pump curve’s “dip region.”

b. Unless otherwise indicated, the required shaft horsepower for the entire pump assembly at any point on the performance curve shall not exceed the rated horsepower of the motor or engine or encroach on the service factor.

c. For VFD driven pumps, the rated horsepower of the selected motor shall be 110 percent of the maximum brake horsepower required by the pump.

2. Compatibility

a. Provide entirely compatible components of each pump system provided under the specific pump Sections.

b. In each unit of pumping equipment, incorporate compatible components such as, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

3. Balancing

a. Unless otherwise specified the rotating assembly shall be dynamically balanced to ISO 1940 G 6.3. Submit Balancing certificate including balancing test procedure and test results.

C. Materials

1. Provide materials suitable for the intended application.

2. For materials not indicated, provide high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements:

a. For drinking water service, use materials with weighted average of lead content of wetted components not to exceed 0.25% to meet the requirement of the Reduction of Lead in Drinking Water Act.

b. Bowls and Casings

1) Provide cast iron pump casings constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30. Unless otherwise indicated on the specific pump sections, cast iron-fitted pumps shall be epoxy lined and coated for better efficiency.

c. Impellers

1) Where individual pump sections indicate cast iron impellers, such impellers shall be epoxy coated and constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30.

2) Where individual pump sections indicate stainless steel impellers, such impellers shall be constructed of Type 316 stainless steel.

3) Where individual pump sections indicate bronze impellers, or where the impeller material is not otherwise specified, such impellers shall be constructed of zero-lead aluminum bronze conforming to ASTM B 148 – Aluminum-Bronze Sand Castings, or zero-lead, zinc less nickel aluminum bronze ASTM B 148-C95800.

d. Provide pump shafts constructed of Type 416 or 316 stainless steel.

e. Provide anti-friction bearings or zero-lead bronze bearings. Bronze bearings shall be Bismuth Tin Bronze ASTM B 584 C89835.

f. All elastomeric materials such as gaskets, seals, O-rings in contact with water with chloramine and ozone shall be Teflon, Viton-A or other materials compatible with the fluid service. Test certificate from a material testing laboratory to provide proof of test shall be made available to the Engineer if requested.

g. Miscellaneous stainless-steel parts shall be of Type 316.

h. Provide anchor bolts, washers, and nuts in standard service (non-corrosive application) of galvanized steel in accordance with the requirements of Section 05500 – Metal Fabrication.

i. Provide anchor bolts, washers, and nuts in corrosive service of stainless steel in accordance with Section 05500 – Metal Fabrication.

3. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Test certificate from a material testing laboratory to provide proof of test shall be made available to the Engineer if requested

2.02 ACCESSORIES

A. Flanges and Bolts

1. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions. Pressure class shall be suitable for the application or as otherwise recommended by the pump manufacturer.

2. Provide flange bolts in accordance with the requirements of Section 15001 – Piping General.

3. Flange gaskets shall be in accordance with Section 15001 - Piping General

B. Lubrication

1. Vertical pump shafts for clean water pumps shall be product water-lubricated, unless otherwise indicated.

2. Provide deep-well pumps with external flushing water- or oil-lubricated bearings and seals, and enclosed line shafts.

3. Pumps for sewage, sludge, and other process fluids shall be grease lubricated or as indicated.

C. Hand holes

1. Provide hand holes on pump casings shaped to follow the contours of the casing in order to avoid any obstructions in the water passage.

D. Drains

1. Provide and connect pipe gland seals, air valves, and cooling water drains to the nearest floor sink or drain, using galvanized steel pipe or copper tube that is properly supported with brackets.

E. Grease Lubrication

1. For vertical propeller and mixed-flow pumps that are not operating continuously such as for flood control application, provide a stainless-steel tube attached to the column for grease lubrication of the bottom bearing.

F. Stuffing Boxes

1. Where stuffing boxes are indicated for the pump seal, provide stuffing boxes of the best quality, using the manufacturer's suggested materials best suited for the specific application.

2. For sewage, sludge, drainage, and liquids containing sediments, provide fresh-water-flushed seals, using lantern rings.

3. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.).

4. Conventional Packing Gland Type Seal

a. Unless otherwise indicated, provide packing material of Teflon braiding, containing 50 percent ultrafine graphite impregnation in order to satisfy the requirements listed in the table below.

b. Acceptable ring materials are asbestos-free die-molded packing rings of braided graphite material free of PTFE, Chesterton 1400R or equal, for non-potable water service, and braided PTFE material,

Chesterton 1725, that is listed under NSF Standard 61 for potable water service.

G. Seal Requirements:

Shaft speeds	up to 2500 fpm
Temperature	up to 500 deg F
pH range	0 - 14

1. Mechanical Seals

   a. Provide mechanical seals of the fresh water-flushed-type, unless otherwise indicated in which case use product water cleaned by a solids separator as indicated above. Seal materials in contact with water with chloramine and ozone shall be Teflon or Viton-A or equivalent material compatible with fluid service.

   b. Provide conventional, non-split-type mechanical seals as manufactured by the following:

Sewage, Sludge, or Wastewater Pumps	Double seals	John Crane Type 5620P, Flowserve Type ISCPP, Chesterton Type GDS or 255
Abrasives, Grit, or Lime Slurry Pumps	Double seals	John Crane Type 5620P (hard faces), Flowserve Type ISCPP or SLC (check with pump manufacturer), Chesterton Type GDS or 255
Chemicals or Corrosive Liquid Pumps	Single seals	John Crane Type 8-1 or 9, Flowserve Type ISCPX, or Chesterton Type UV, GSS, or 155
Water Pumps (hot and cold)	Single seals	John Crane Type 5610Q, Flowserve Type ISCPX, Chesterton Type UV, GSS, or 155

   c. Provide split-type mechanical seals as manufactured by the following:

Sewage, Sludge, or Wastewater Pumps	Double seals	John Crane Type 3710, Flowserve Type PSS2, Chesterton Type 442
Abrasives, Grit, or Lime Slurry Pumps	Double seals	Split seals are not recommended.
Chemicals or Corrosive	Single seals	Split seals are not recommended

Liquid Pumps		because of leakage.
Water Pumps (Hot and cold)	Single seals	John Crane Type 3710, Flowserve Type PSS II, Chesterton Type 442

d. Where indicated, circulate a buffer fluid at a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.

e. Equip mechanical seals with non-clogging, flexible–mounted seats with elastomer secondary seals.

f. Provide wetted metal parts constructed of Type 316 stainless steel, Alloy 20, or Hastelloy B or C, whichever has the best corrosion resistance to the pumped fluid.

g. Where double seals are specified, provide double-balanced dual cartridge seals in order to allow for seal integrity in case of flush water pressure reversal.

h. Provide springs in single and double seals, in the non-wetted end of the seal.

i. Deliver fresh water to the seals through appropriate size piping with plug valves, strainers, pressure regulators, electrically operated solenoid valves, and rotameters.

j. Wiring shall comply with the requirements of Division 16 – Electrical, and control shall comply with the requirements of Division 17 – Instrumentation and Control.

2.03 PUMP APPURTENANCES

A. Nameplates

1. Equip each pump with a stainless-steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. Solenoid Valves

1. Require the pump manufacturer to provide solenoid valves on the water or oil lubrication lines and on cooling water lines.

2. Provide solenoid valve electrical ratings compatible with the motor control voltage.

C. Gauges

1. Except for sample pumps, sump pumps, and hot water circulating pumps, equip pumps with pressure gauges installed at the pump discharge lines.

2. Provide pump suction lines with compound gauges.

3. Located gauges in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

4. Where subject to shock or vibrations, wall-mount the gauges or attach the gauges to galvanized channel floor stands and connect by means of flexible connectors.

2.04 PROTECTIVE COATING

A. Coat materials and equipment in accordance with the requirements of Section 09960 – High Performance Coatings.

PART III - EXECUTION

3.01 SOURCE TESTING

A. Factory Testing: Conduct the following tests on each indicated pump system:

1. Motors

a. Test electric motors in accordance with the requirements of Section 16220 – Low-Voltage Electric Motors.

b. Furnish test results to the pump manufacturer prior to the pump test.

2. Variable Frequency Drives

a. Test variable frequency drives in accordance with the requirements of Division 16 – Variable Frequency Drives section.

b. Furnish test results to the pump manufacturer prior to the pump test.

3. Certified Factory Non-witnessed Test

a. Perform factory non-witnessed tests on pumps with drives up to and including 125 hp in accordance with the ANSI/HI 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Test.

b. For pumps with drives smaller than 15 hp, sump pumps, and sample pumps, pumps shall meet hydraulic acceptance criteria Grade "2U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

1) Hydrostatic test in accordance with ANSI/HI 1.46 Appendix B - Hydrostatic Pressure Testing.

2) Performance test at guaranteed design point or duty point documenting head, flow, bhp, and efficiency results.

3) Unless otherwise indicated, it is not required to test NPSHr in the factory. Instead, manufacturer shall submit the published NPSHr curve in accordance with the requirements of this specification section.

4) Additional tests as indicated in the specific pump specification sections.

5) For pumps with drives 15 hp and larger shall meet hydraulic acceptance criteria Grade "1U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

6) Performance Test:

a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute Standard.

b) For variable speed driven pumps, test each pump between maximum and minimum speed at intervals no greater than 100 RPM.

c) Submit pump curves showing head, flow, bhp, NPSHr and efficiency results. The manufacturer’s certification shall be visible on each submitted curve;

7) Mechanical testing shall be limited to observation during the hydraulic performance test for any abnormal bearing temperature and pump vibration. Any deficiencies shall be corrected by the manufacturer.

8) NPSHr3

a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.

b) Acceptance criteria shall be in accordance with ANSI/HI 14.6

c) If not required by the specific pump Section, submit the published manufacturer calculated NPSHr3 curve.

9) Additional tests as indicated in the specific pump specification sections.

c. Perform tests for all pumps using the completely assembled project pump, motor, and VFD system (if equipped with variable speed drive). Calibrated factory motor may be used in lieu of project motor subject to approval of the Engineer.

d. Where multiple pumps are required in the project, one project variable speed drive and motor of each size shall be used for testing for all pumps as completely assembled systems.

e. Testing of prototype models will not be accepted.

f. Submit certification signed by a senior official of the pump manufacturer that the required pump shaft horsepower did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

g. No equipment shall be shipped until the test data have been approved by the Engineer.

4. Certified Factory Witnessed Tests

a. Not Applicable

5. Acceptance

a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

3.02 PROTECTION DURING SHIPMENT AND STORAGE

A. General: Unless otherwise specified in the specific Section for the equipment, this paragraph applies.

1. Shipping:

a. Equipment: Ship in sealed, weather-tight enclosed containers with silica gel desiccants to protect equipment from moisture and corrosion during shipment. Equipment shall be properly and protected against from being damaged or stresses during transport to the job site.

b. Bearing housings: Protect antifriction bearings from being damaged in transit due to moisture and contaminants. Shafts locked to equipment housing to prevent bearing damage during shipment.

2. Damage: Correct to conform to the Contract requirements before the assembly is incorporated into the work.

3. Factory applied coatings: Each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied prime coating.

4. Special monitoring: For the equipment listed below, a recording accelerometer, designed to record the magnitude of sudden impacts in 3 directions (X, Y, Z) on continuous strip charts with both time and "g" force scales, shall be shipped with, and fixed to each separately packed assembly or its packing crate. The units shall be shipped with a backup accelerometer and with new batteries. Upon arrival of each shipment, immediately notify the Project Representative; the accelerometer: shall be removed in the presence of representatives of the Project Representative and the Contractor. If the magnitude of the maximum acceleration exceeds 3.0 g, the assembly and any subassembly shall be dismantled and inspected for damage.

5. The following equipment shall be monitored during shipment:

   a. All electric motors and pumps 500 horsepower and larger.

   b. All variable speed drive units of all sizes.

   c. All engine generators and controllers of all sizes.

   d. All blowers and motors 500 horsepower and larger.

3.03 SERVICES OF MANUFACTURERS

A. Inspection, Startup, and Field Adjustment

1. Where required by the specific pump Section, furnish an authorized service representative of the manufacturer at the Site continuously to supervise the following items and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

   a. Installation of the equipment.

   b. Inspection, checking, and adjusting the equipment.

   c. Startup and field testing for proper operation; and

d. Performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements.

e. Inspection, Startup, and Field Adjustment

B. Instruction of Owner's Personnel:

1. Where required by the individual pump Section, furnish an authorized training representative of the manufacturer at the Site for the number of Days indicated in the specific pump Section, to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. A minimum of two separate day trips shall be furnished.

2. Furnish instruction specific to the model of equipment provided.

a. Qualifications

1) Furnish a representative with at least 2 years' experience in training.

b. Resume: Submit a resume for the representative.

c. Schedule: Schedule the training a minimum of 3 weeks in advance of the first session.

d. Lesson Plan: Lesson Plan Review

1) Submit the proposed training material and a detailed outline of each lesson for review.

2) Incorporate review comments into the material.

3) The trainees will keep the training materials.

4) The Owner may videotape the training for later use with the Owner's personnel.

3.04 INSTALLATION

A. General

1. Install pumping equipment in accordance with the manufacturer's written recommendations.

B. Alignment

1. All pump bases shall be grouted in place after initial fitting and alignment of suction and discharge piping, but before final bolting of the connecting piping. The suction and discharge flange piping shall be laser aligned to the centerline of the pump nozzles and mating flanges square and parallel with each other. No pipe strain shall be transferred to the pump nozzle. After alignment and bolting, connections to the pump flange shall be checked using dial indicators for applied strain by loosening the flange bolts. If any of the flanges or joints move away (axially or laterally) from the true centerline of the pipe is observed, the piping shall be adjusted for proper fit.

2. Check equipment alignment after the grout had cured, all bolts torque checked and coupling adjusted to verify proper alignment and freedom from binding, scraping, shaft run out, or other defects.

3. Rotate the equipment manually and measure if shaft runout is within acceptable tolerance in order to ensure correct alignment without forcing.

4. Ensure that the equipment is secure in position and neat in appearance.

C. Submit certificate of affirmation that the equipment has been installed and aligned in accordance with the manufacturer's instruction. Installation and alignment check certificate shall be signed by the Contractor, Manufacturer and witnessed by the Engineer.

3.05 FIELD TESTS

A. Field-test each pump system after installation simulating all of the operational scenarios as specified in order to demonstrate:

1. Satisfactory operation without excessive noise and vibration.

2. No material loss caused by cavitation.

3. No overheating of bearings; and,

4. Meet indicated head, flow, and efficiency at the design point as specified in Specification 11140 – Self Priming Horizontal Non-Clog Pumps section 2.01 and 11305 – Submersible Non-Clog Sewage pumps section 3.10.

B. Conduct the following functional field testing:

1. Startup, check, and operate the pump system over its entire speed range.

2. If the pump is driven by a variable speed drive, test the pump and motor at 100-RPM increments.

3. If the pump is driven by constant speed, test the pump and motor at the maximum RPM.

4. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute standards at a minimum of 4 pumping conditions defined by the Engineer.

5. Unless otherwise indicated, noise shall be within the limits recommended by the Hydraulic Institute standards.

6. Field performance test: Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed, at 100-RPM increments if equipped with a variable speed drive or at maximum RPM if equipped with a constant speed drive.

7. Check each power lead to the motor for proper current balance.

8. Bearing Temperatures

    a. Measure bearing temperatures by a contact-type thermometer.

    b. Precede this test with a run time sufficient to stabilize bearing temperatures unless an insufficient liquid volume is available to furnish such a run time.

9. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.

C. Witnessing

1. Field testing will be witnessed by the Engineer and the Owner representative.

2. Furnish 14 Days advance notice of field testing.

D. If the pumping system fails to meet the indicated requirements, modify or replace the pump and re-test as indicated above until it satisfies the indicated requirements.

E. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.

2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.

F. The Contractor shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the Owner will bear.

G. If available, the Owner’s operating personnel will provide assistance in field testing.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide self-priming horizontal non-clog pumps, with electric motors and appurtenant work, complete and operable, in accordance with the Contract Documents.

B. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
01650	Facility Startup/ Commissioning
01730	Operation and Maintenance Data
09960	High-Performance Coatings
11000	Equipment General
11100	Pumps General
16220	Motors
17900	Plant Control Philosophy

1.03 REFERENCES

A. Reference Standards

American National Standards Institute (ANSI)	
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings 125, 250, and 800 lbs
ASTM International (ASTM)	
ASTM A48	Gray Iron Castings
ASTM A108	Steel bars, Carbon, Cold Finished, Standard Quality
ASTM A153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM A385	Standard Practice for Providing High-Quality Zinc Coating (hot-Dip)

Hydraulic Institute Standards - all

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals.

B. Shop Drawings: Submit complete fabrication, general assembly, foundation requirements, and installation Drawings for all pumps, motors, and accessories to illustrate construction and assembly of components.

C. Product data: Provide manufacturer's literature including general assembly, materials of construction, performance characteristics, coatings, power requirements, wiring diagrams, service connections, and additional information necessary to determine compliance with these Specifications:

D. Pump:

1. Name of manufacturer
2. Type and model
3. Rotative speed
4. Size of suction nozzle
5. Size of discharge nozzle
6. Type of bearings
7. Net weight of pump only
8. Net weight of components and total assembly including motor
9. Complete performance curves showing capacity versus head, NPSH required, pump efficiency and BHP
10. Type and construction of seals.
11. Type of coupling
12. Data on shop painting

E. Motors:

1. Name of manufacturer
2. Type and model

3. Type of bearings and shaft
4. Rated size of motor hp
5. Temperature rating
6. Full load rotative speed
7. Net weight
8. Efficiency at full load and rated pump condition
9. Full load current
10. Locked rotor current

F. Manufacturer's installation instructions: Provide connection requirements and start-up instructions for pumps.

G. Test reports:

1. Submit certified copies of shop test reports for each pump supplier at least 10 days before shipping equipment.
2. Reports shall include:
    a. Test log
    b. Description of test piping, equipment and setup
    c. Test procedure
    d. Certified performance curves, plotted against capacity:
        1) Head
        2) Brake horsepower
        3) Efficiency
        4) Actual speed
        5) Net positive suction head required

H. Operation and Maintenance Manuals:

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

1.05 DELIVERY STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 01600 –Materials and Equipment

B. Accept pumps and components on site in factory packing. Inspect for damage. Comply with manufacturer's installation instructions.

1.06 WARRANTY

A. The equipment seller shall be solely and fully responsible for warranty and mechanical design adequacy of all the pump components in the scope of supply defined in this section of the specification. This warranty shall become effective for a period of one (1) year from the date of substantial completion.

PART II - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. General:

1. Stable and free of cavitation and noise throughout the specified operating head range

2. Minimum hydrostatic test pressure: 1.5 times the shutoff head plus suction pressure

3. Design based on running clearance between the impeller and suction cover of at least 0.015 inch

4. Terminology used conforms with that of the Hydraulic Institute Standards

5. Solids Handling Capability

   a. All internal passages, impeller vanes, and recirculation ports shall pass a 3.0” spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the engineer, manufacturer’s certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

6. Reprime Performance

   a. During unattended operation, the pump shall retain adequate liquid in the casing to ensure automatic repriming while operating at its rated speed in a completely open system.

   b. The pump must reprime 20 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of the

pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition.

B. Operating Conditions: The work of this Section shall be suitable for long-term operation under the following conditions:

Duty	Continuous
Ambient environment	Outdoors
Minimum temperature, degrees F	20
Maximum Temperature, degrees F	105
Fluid service	Dewatering Filtrate
Project site elevation, ft (m.s.l)	437
Minimum available NPSH, ft absolute	15.20
Electrical Requirements	Class 1, Div 2

C. EQ Transfer Pumps

Equipment Number	LSPUMP-04, LSPUMP-05, LSPUMP-06
Quantity	2 Duty + 1 Standby
Location	EQ Transfer Lift Station
Pump Operation	VFD

1. Performance Requirements

Minimum flow capacity per pump, gpm	250
Flow to ATR Influent Splitter Box (Normal Operation) pump head TDH, ft	
Maximum EQ Basin WSL Elevation	7.7
Minimum EQ Basin WSL Elevation	22.5
Flow to ARF Effluent Channel (Drain Operation) pump head TDH, ft	

Maximum EQ Basin WSL Elevation	7.1
Minimum EQ Basin WSL Elevation	27.4
Design/ Maximum flow capacity per pump, gpm	500
Flow to ATR Influent Splitter Box (Normal Operation) pump head TDH, ft	
Maximum EQ Basin WSL Elevation	12.7
Minimum EQ Basin WSL Elevation	27
Flow to ARF Effluent Channel (Drain Operation) pump head TDH, ft	
Maximum EQ Basin WSL Elevation	15.3
Minimum EQ Basin WSL Elevation	35
Maximum motor size, hp	10

2. Pump Dimensions

Suction diameter, in	6
Discharge diameter, in	6
Suction flange rating, ANSI, psi	150
Discharge flange rating, ANSI, psi	150

D. ARF Effluent Pumps

Equipment Number	LSPUMP-07, LSPUMP-08, LSPUMP-09
Quantity	2 Duty + 1 Standby
Location	ARF Effluent Lift Station
Pump Operation	Constant Speed
Alternative Operation	Mechanical Pully

1. Performance Requirements

Flow capacity per pump, gpm	500
Design flow pump head per pump, TDH ft	
Flow to Pond 1W (Normal Operation)	62.5
Flow to SSTP (Alternative Operation)	72.5
Maximum motor size, hp	20

2. Pump Dimensions

Suction diameter, in	6
Discharge diameter, in	6
Suction flange rating, ANSI, psi	150
Discharge flange rating, ANSI, psi	150

2.02 PUMP REQUIREMENTS

A. General: Construction of self-priming horizontal non-clog pumps shall conform to the following requirements:

Casing and frame	Cast iron, ASTM A 48, with removable coverplate for inspection or service
Pump base	Cast iron base plate
Impeller	Ductile iron ASTM A 395 or A 536, statically and dynamically balanced, open
Wear plate	Type 316 stainless steel, replaceable
Cover plate	Cast iron, removable and adjustable
Shaft and sleeve	17-4 Precipitation hardened stainless steel
Seal	Cartridge type, flushless double mechanical seal, with silicon carbide rotating and stationary faces

Coupling	Flexible heavy duty spacer shaft coupling with guard
Bearings	Ball bearings with min L-10 life of 50,000 hours at max load
Flap valve	Neoprene with steel reinforcing
Gaskets and O-rings	Buna-N
Hardware	Type 316 Stainless steel

B. Drive: Constant speed drive with TEFC heavy duty, horizontal, inverter-duty electric motor suitable for 480-volt, 3-phase, 60-Hz power supply, in accordance with Section 16220 –Motors. The service factor shall be 1.15.

C. Casing:

1. Permits removal of the rotating element without disconnecting the piping

2. Flanged clean out hand holes on discharge and suction nozzles with interior surfaces flush with the casing water passages

3. Parts to have registered fit for alignment

4. Nozzle flanges: ANSI 125 lb diameter and drilling

5. Pipe tapped openings with gage cocks for draining, priming, and venting the casing

D. Impeller:

1. Two-vane, open type

2. One-piece casting completely machined on all exterior surfaces

3. Statically and dynamically balanced per Hydraulic Institute Standards

4. Keyed and locked to the shaft with a self-locking or pinned non-clog type fastener

5. Uniform sections and smooth surfaces free from cracks and porosity on interior water passages

E. Shaft and shaft sleeves:

1. Shaft completely machined

2. Shaft deflection at stuffing box not more than 0.002 inches at any operating head

3. Replaceable sleeve extending from the impeller through the stuffing box

4. Sleeve positively locked against rotation and axial movement

5. Sleeves sealed to prevent leakage between shaft and sleeve

6. Total shaft run out less than 0.002 inches

F. Wearing rings for enclosed impeller pumps:

1. Provide renewable wearing rings in casing

2. Design clearance at least 1 mil/in. of ring diameter

3. Casing ring positively locked in place

G. Bearings:

1. Anti-friction type

2. Oil lubricated

3. Minimum life (AFBMA L-l0) rating: 100,000 hrs

4. Rated for max shaft speed

5. Located in common cavity as mechanical seal

H. Frame assembly:

1. Rigidly support the rotating element with 2 bearings

2. Outboard bearing to carry both radial and axial loads

3. To permit axial adjustment of rotor without dismantling

4. Bearing enclosures to keep out contaminants and retain lubricant and with adequate provisions for adding and flushing lubricant

5. Ample clearance for stuffing box maintenance

I. Balance:

1. Accurately machine all rotating parts

2. Place pump in as near perfect rotational balance as practicable

3. Equipment which vibrates excessively will be rejected

4. The mass of the unit and its distribution shall preclude resonance at any operating speed

J. Limits:

1. Max peak-to-peak vibration displacement at any point on the machine: 2.0 mils

2. Max peak-to-peak vibration displacement of shaft at face to stuffing box: 2.0 mils

3. Ratio of rotative speed to critical speed of unit or components: Less than 0.8 or more than 1.3

K. Mechanical seals:

1. Balanced, flushing type

2. Double floating, self-aligning

3. Oil lubricated

L. Assembly:

1. Mount pump and drive on common base

2. Connect motor to pump with belts and sheaves

3. Provide belt guard

4. Connect pump and drive shaft with flexible coupling

5. Mount motor in vertical position

M. Protective Coating

1. Pumps shall be coated in accordance with Section 09960 – High-Performance Coating.

2. Pump, motor and other non stainless steel components shall have epoxy paint finish.

3. Apply rust preventive compound to all machines, polished an non ferrous surfaces that are not to be painted.

N. Air Release Valves

1. An automatic air release valve shall be furnished for each pump designed to permit the escape of air to the atmosphere during initial

priming or unattended repriming cycles. Upon completion of the priming cycle or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visual indication of valve closure and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable.

2. All valve parts exposed to sewage shall be constructed of cast iron, stainless steel, or similar corrosion resistant materials. Diaphragms, if used, shall be of fabric reinforced neoprene or similar inert material.

3. A cleanout port, three inches in diameter, shall be provided for ease of inspection, cleanout, and service.

4. Valves shall be field adjustable for varying discharge heads.

5. Connection of the air release valves to the station piping shall include stainless steel fittings.

O. Gauge Kit

1. Each pump shall be equipped with a glycerin filled compound gauge to monitor suction pressures, and a glycerin filled pressure gauge to monitor discharge pressures.

2.03 PUMP CONTROLS

A. Pumps shall be controlled in accordance with Section 17100 – Process Instrumentation and Control System.

2.04 SPARE PARTS

A. Each pump shall be provided with the following spare parts:

1. One complete set of wear rings

2. One bearing set

3. One complete mechanical seal

4. One full gasket kit

5. One shaft sleeve

6. One year supply of all greases and lubricants for each pump

2.05 MANUFACTURER

A. Gorman Rupp

B. WEMCO

PART III - EXECUTION

3.01 COORDINATION

A. Pump manufacturer shall be responsible for coordination with variable frequency drive manufacturer and motor manufacturer through CONTRACTOR to ensure compatibility over full range of operation.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and on equipment base as indicated on Drawings and in accordance with Specification 11100 – Pumps General.

B. Provide anchor bolts in accordance with manufacturer's instructions.

C. Level, plumb and align unit into position to fit connecting piping.

D. Grout pump base after initial fitting and alignment but before final bolting of connecting piping. Take special care to maintain alignment of components. No strain shall be transmitted to the pump flanges. Test pump connections for piping stresses after final alignment and bolting:

1. Loosen flange bolts

2. If any movement or opening of joints is observed, adjust piping to fit

3. Realign couplings after grouting

4. Do not shim between machined surfaces

3.03 FIELD START-UP SERVICES

A. Field services shall be furnished in accordance with Section 11100 – Pumps General.

B. Inspection, Startup, and Field Adjustment: Provide manufacturer's field service representative for a minimum of one day (8 hours) to inspect installation and witness field testing.

C. Instruction of OWNER’s Personnel: The training representative of the manufacturer shall be present at the Site two separate days for 4 hours (each trip) to furnish the services required by Section 11100 – Pumps General.

D. Perform clear water test and record performance of each pump in accordance with Hydraulic Institute Standards.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The Contractor shall provide vertical shaft mixer and appurtenances, complete and operable, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
01730	Operation and Maintenance Data
05500	Metal Fabrications
11000	Equipment General
16220	Motors
16480	Variable Frequency Drives

1.03 REFERENCES

A. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASTM International (ASTM)	
ASTM A48	Gray Iron Castings
ASTM A470	Vacuum-Treated Carbon Alloy Forgings for Turbine Rotors and Shafts
ASTM A536	Ductile Iron Castings
ASTM B62	Composition Bronze or Ounce Metal Castings
National Fire Protection Association (NFPA)	
NFPA 70	National Electric Code
American Water Works Association (ANSI)	
ANSI B16.1	Cast iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Submittals.

B. Shop Drawings

1. Equipment name, identification number and specification number.

2. Performance data.

3. The Contractor shall require the manufacturer to indicate the limits recommended for stable operation between which the mixer may be operated without surge, cavitation, or vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.

4. Equipment detailed description and specification.

5. Electrical data including control and wiring diagrams.

6. Assembly and installation drawings including shaft size, seal, coupling, anchor bolt plan, part nomenclature, material list, outline dimensions and shipping weights.

7. Drive and motor data in accordance with Section 16480 – Variable Frequency Drives and 16220 –Motors.

C. Certification: The Contractor shall obtain written certification from the manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all equipment, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The Contractor shall submit all such certificates to the Engineer.

D. O&M Manuals

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. All equipment in this Section shall be furnished by or through a single supplier. The Contractor shall be responsible for the coordination and proper operation of the entire system. Equipment shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the Drawings, Specifications, instructions and recommendations of the equipment manufacturer.

B. Qualifications of Manufacturer: The manufacturers shall be experienced in the design and construction of equipment for this purpose and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

1.06 WARRANTY

A. The equipment seller shall be solely and fully responsible for warranty and mechanical design adequacy of all the mixer components in the scope of supply defined in this section of the specification. This warranty shall become effective for a period of one (1) year from the date of substantial completion.

PART II - PRODUCTS

2.01 GENERAL

A. Mixers shall be of the non-clogging, vertical shaft, hyperboloid-body type.

B. The mixer and its appurtenances shall be specifically designed for continuous duty operation in a submerged application in a biological reactor. The mixers shall not overload the motors at any point within the operating limits recommended by the mixer manufacturer.

C. The mixer shall be designed with a dry installed motor. The entire weight of the mixers shall be supported by existing concrete bridges/walkways.

2.02 PERFORMANCE REQUIREMENTS

A. The mixers shall be capable of completely mixing the EQ basin as required to meet the requirements of the performance test outlined below. Each test will be conducted in the presence of the Engineer and the Owner. The performance requirements presented below define the minimum mixing capacity of each mixer. If additional mixing capacity is required to meet the performance test requirements, the Contractor shall provide the necessary equipment at no additional cost to the Owner.

B. Mixers installed in the EQ Basin shall be designed to meet the following conditions:

Description	**Value**
Process Application	Equalization Basin
Fluid Service	Dewatering Filtrate
No. of Mixers	1

Equipment Tag	MIXER-03
Mixer Configuration	Hyperbolic
Mixer Body	Single body with 8 integral transport ribs
Average Percent Solids (%)	<=0.2
Maximum Percent Solids (%)	1
Sludge Volume Index, ml/g	>=80
Maximum Mixer Body Speed, RPM	30
EQ Basin Size, ft (L x W x SWD)	70 x 60 x 19.5
Top of Wall Elevation, ft	448.50
Top of Bottom Slab Elevation, ft	426
Motor	
Horsepower, hp	10
Maximum Speed, rpm	1800
Type	Squirrel Cage, Induction Type
Efficiency	NEMA MG1 Premium Efficiency
Design	Design B
Duty	Continuous
Insulation	Class F
Voltage	460V, 3Ph, 60 Hz

Service Factor	1.15

2.03 MATERIALS

A. Materials shall be suitable for the intended application; material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, materials shall conform to the following requirements:

1. Cast iron casings shall be of close-grained gray cast iron, conforming to ASTM A 48.

2. Bronze impellers shall conform to ASTM B 62.

3. Stainless steel shafts shall be of Type 300 or 400 Series, as best suited for the purpose. Miscellaneous stainless steel parts shall be of Type 316.

4. All anchor bolts, nuts and washers shall be in accordance with Section 05500 - Metal Fabrications.

B. General

1. Each mixer assembly shall consist of a dry installed heavy-duty speed reducer with hollow shaft, electric motor, baseplate, composite FRP shaft, and composite hyperbolic mixer body.

2. The bottom of the hyperbolic mixing body should not exceed 12” above the basin floor or installed diffusers.

3. Mixers shall be capable of handling biological activated sludge with a solids concentration from 0.01 to 1 percent solids with a SVI of minimal 80 ml/g., and shall be designed to prevent settlement in the tanks and to re-suspend biological material on the tank bottom.

4. The mixer should be designed as a vertical shaft mixer, with a dry installed motor. During operation the mixer should not generate any upward forces on the bridge construction.

5. The mixer should have a steady stationary flow pointed downward parallel to the mixer shaft. The highest speeds and turbulent fluctuations should be produced in the bottom area. On the water surface, no or little surface turbulence should appear.

C. Gear Drive

1. The gear drive assembly for each mixer shall consist of parallel-shaft helical gear box and motor as designed by SEW Eurodrive.

2. The gear drive assembly shall have a high-quality corrosion protection coating, robust weather protective hood, and PTC resistor for thermal protection of the motor.

3. The gear box housing shall be cast iron covered with an acrylic coating, having a thickness of at least 6.0 mil. The gear box shall be connected to the mounting base using a flange connection with 316 additional stainless steel nuts and bolts.

4. The gear box speed shall not exceed 30 rpm. The calculated lifetime L10 of the bearings shall exceed 100,000 hours.

5. The drive motors shall be a squirrel cage induction motor, 460 V, 3 phase, 60 Hz, 1,800 RPM, Class F insulation.

6. The motors shall be equipped with a weather protection hood.

7. The motors shall be equipped with integral thermal overloads mounted in the motor windings.

8. The hollow shaft shall be covered and sealed with a special hollow shaft cap.

D. Mounting base

1. The mounting base of each mixer shall consist of a gear base plate mounted in rubber buffers connected permanently to the bridge/supports by bolted connection. The plate shall be able to be leveled using the threaded bolts, which can be adjusted in height.

2. The rubber buffers shall absorb start-up torque, prevent any transfer of vibrations to the bridge and constitute the galvanic separation of the mixer from its surroundings.

3. The mounting base shall be a fastening set for the concrete bridge/walkway with threaded rods and chemical anchors which are permanently anchored to the concrete.

E. Shaft

1. The drive shaft of the mixer shall be made from FRP.

2. At the top end of the mixer shaft, there shall be a tappet for the connection to the gear hollow shaft.

3. At the lower end there, shall be a flange connection to the mixer body itself.

4. All bolted connections shall utilize 316 stainless steel hardware.

F. Hyperboloid Mixer Body

1. Each hyperboloid mixer body shall be manufactured of FRP and be a streamlined stress-free body without any mounted or fitted parts.

2. The transport ribs which accelerate the flow shall be integrated in the mixer body.

3. The mixer body shall be coated with a special gel coat to provide a polished surface.

4. The hyperboloid mixer shall have laminated stainless steel insert nuts.

G. Spare parts

1. One set of rubber buffers per installed mixer type.

2. One shaft holder for each shaft diameter supplied.

3. All lubricating oils required for the first year of operation shall be provided. The products supplied shall be factory prefilled, in accordance with manufacturer's recommendations.

4. Spare parts shall be identical to and interchangeable with similar parts installed.

H. Tools

1. Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for pumps, mixers, flocculators, and motors shall be furnished as a part of the work hereunder; such tools shall be suitably stored in metal tool boxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

I. Manufacturers

1. Invent Environment Technologies, Inc

2.04 APPURTENANCES

A. Nameplates: Each piece of equipment shall be equipped with a stainless steel nameplate indicating rated performance, size, speed, and manufacturer's name and model number.

B. Solenoid Valves: The equipment manufacturer shall provide any solenoid valves on water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be provided complete with all necessary conduit and wiring installation from control panel to solenoid.

C. Variable Speed Drives: Variable speed drives, speed control equipment, and accessories shall be provided in accordance with Section 16480 - Variable Frequency Drives.

D. Motors: Motors shall be heavy duty and shall comply with Section 16220 – Motors.

E. Flanges: Equipment flanges shall conform to ANSI B16.1 or B16.5 dimensions.

F. Lubrication: Equipment shafts, bearings, gears, and other moving parts shall be grease, oil, or product lubricated. All lubricating points shall be filled with the recommended lubricants.

G. Equipment: Gland seals, air valves, and cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

H. Equipment Seals: Seals on equipment shafts shall be the manufacturer's suggested best quality mechanical seals or stuffing boxes, as best suited for each individual application. Where necessary, such seals shall be oil lubricated or water-flushed.

PART III - EXECUTION

3.01 INSTALLATION

A. General: Equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. Alignment: Equipment shall be field tested to verify proper alignment, operation as indicated, and freedom from binding, scraping, overheating, vibration, shaft runout, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: Installation shall include the necessary oil and grease for initial filling and one year's operation.

D. Placement of the anchor bolts shall be determined by the Contractor from certified dimension prints supplied by the equipment manufacturer.

3.02 FACTORY TEST

A. The hyperbolic mixer manufacturer shall perform the following inspections and tests on each unit before shipment:

1. Hyperbolic mixer body diameter, motor rating, and electrical connections shall be checked for compliance with contract requirements and tolerances.

2. The following tests shall be performed on the SEW gearmotors:

    a. One-second-high potential test

    b. No-load run test including no-load current, no-load speed, phase deviation current and no-load motor power.

    c. Visual inspection of the unit.

    d. Tester shall inspect for any abnormal noise.

B. Certified copies of all test procedures and results shall be provided to the Engineer prior to shipment.

3.03 FIELD START-UP SERVICES

A. Inspection, Startup, and Field Adjustment: Provide manufacturer's field service representative for a minimum of one day (8 hours) to inspect installation and witness field testing.

B. Instruction of OWNER’s Personnel: The Contractor shall furnish the services of a factory service representative to instruct the Owner's personnel in the operation and maintenance of the equipment. The training representative of the manufacturer shall be present at the Site two separate days for 8 hours, each trip.

C. The following performance test shall be performed in the field:

1. Prior to start of the performance tests, fill the EQ Basin to the maximum water elevation with test water as specified in Section 2.02.B.

2. Run the mixer for one hour at maximum design conditions as specified in section 2.02.B. Demonstrate each mixer:

    a. Is free of overheating of any parts.

    b. Is free of all objectionable vibration, in accordance with manufacturer's recommendations.

    c. Is free of overloading of any parts.

3. Via the Control Station(s), verify mixer functions.

4. Record amperage draw.

5. Continue operating the mixer for 24 hours without overheating, excessive vibration or overloading.

6. Certified copies of all test procedures and results shall be provided to the Engineer.

3.04 ACCEPTANCE

A. In the event of failure of any equipment to meet any of the above requirements or efficiencies, the Contractor shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the equipment shall be re-tested until found satisfactory.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The MANUFACTURER shall furnish the process and control system equipment for a biological wastewater treatment system, as shown on the Contract Drawings and specified herein. The process equipment shall generally include, but is not limited to, AnoxKaldnes K5 media, a medium bubble aeration system, cylindrical screen assemblies, air lift pumps, mixer(s), process control PLC-based panel, instrumentation, seed media, technology licenses, and patent infringement indemnification. A single MANUFACTURER shall supply the Biological Treatment System as defined herein in order to establish system performance responsibility.

B. Mechanical instrumentation and electrical process equipment to be furnished under this section includes, but is not limited to, the following:

1. AnoxKaldnes K5 polyethylene media
2. AnoxKaldnes medium bubble aeration system
3. Two (2) modulating air flow control valves
4. Nine (9) manual airflow isolation valves, per reactor
5. Two (2) cylindrical screen assemblies, per reactor
6. Instrumentation, as identified herein
7. Five (5) air lift pumps and one (1) orifice plate fitting for foam control, per reactor
8. Two (2) top motor mounted hyperbolic mixers, per reactor
9. ATR drain screens as shown on the Contract Drawings
10. Process control panel

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
01400	Quality Control Services
01600	Products, Materials, Equipment and Substitutions
01650	Facility Startup/ Commissioning
05500	Metal Fabrications

11000	Equipment General
11376	Positive Displacement Blower
15001	Piping General
15006	Hangers and Supports for Process Piping
15023	Stainless Steel Process Pipe and Tubing
15202	Butterfly Valves
15205	Common Requirements for Process Valves
16010	Electrical General Provisions
16011	Identifications
16200	Wires Conductors Cables- 600V and Below
16205	Wire and Cable Tagging
16220	Motors
16950	Grounding
16950	Calibration and Testing
16480	Variable Frequency Drives
17100	Process Instrumentation and Control System
17200	Instrument and Control Cabinets and Associated Equipment
17600	PLCs & OIUs Equipment
17620	Fiber Optic & Ethernet Communication Equipment
17900	Plant Control Philosophy
17102	Flow Measuring Systems
17122	Pressure Gauges
17310	Pressure Indicating Transmitter
17320	Temperature Gauges
17345	Radar Level Element & Indicating Transmitter
17370	Mechanically Activated Level Switches

1.03 REFERENCES

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

B. Equipment shall be in accordance with the following standards including MANUFACTURER's published recommendations, as applicable:

1. American Society for Testing and Materials (ASTM).
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME).
4. American Welding Society (AWS).
5. AWS D1.6 - Structural Welding Code: Stainless Steel
6. National Fire Protection Association (NFPA).
7. Federal Specifications (FS).
8. National Electrical Manufacturers Association (NEMA).
9. National Electric Code (NEC).
10. Occupational Safety and Health Administration (OSHA).
11. American Iron and Steel Institute (AISI)
12. American Institute of Steel Construction (AIWC)
13. American Gear Manufacturers Association (AGMA)
14. International Society of Automation (ISA)

1.04 DEFINITIONS

A. SCFM: A standard cubic feet per minute is understood to be air at 68°F, 14.7 PSIA and 36% relative humidity flowing at a rate of 1 cubic foot per minute.

B. SOTR: Standard oxygen transfer rate is understood to be the rate of oxygen transferred to tap water (pounds of oxygen per hour) at standard conditions of 68°F, 0.0 mg/l residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air).

C. SOTE: Standard oxygen transfer efficiency is understood to be the fraction of oxygen transferred under standard conditions of 68°F, 0.0 mg/l residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air).

D. SWD: Side water depth is understood to be the overall dimension from the high point of the basin floor to the water surface.

1.05 SYSTEM DESCRIPTION

A. The Moving Bed Biofilm Reactor (MBBR) Deammonification process allows carrier elements (media) to move about freely within a reactor using the

medium bubble aeration system in aerobic reactors. Screen assemblies shall be used to retain the media within the reactor(s).

B. A MBBR system shall be installed as part of the new Ammonia Removal Facility (ARF) and shall be designed to oxidize ammonia-nitrogen and reduce the total inorganic nitrogen (TIN) contained in dewatering filtrate.

C. The MANUFACTURER shall provide all anchor bolts for all equipment being provided by the MANUFACTURER. MANUFACTURER shall be responsible for sizing the anchor bolts, which shall be signed off on by a licensed Professional Engineer. Refer to Structural General Notes on 00-S-002 for additional requirements for anchor bolts. All in-tank anchors shall be 316/316L SS.

D. The OWNER shall provide required laboratory equipment, laboratory facilities and analytical work required for startup, adjustment and performance testing per MANUFACTURER submitted startup and performance testing requirements.

1.06 GENERAL CONTRACTOR SCOPE OF WORK

A. The CONTRACTOR shall install all equipment and materials as provided by the MANUFACTURER.

B. The CONTRACTOR shall supply and install all pipe sections, wall penetrations, and pipe supports as required for the MBBR Deammonification equipment and as shown on the Contract Drawings and required to connect to the MANUFACTURER supplied equipment.

C. At interfaces with media retention screen(s) of all types, the CONTRACTOR shall supply, install, and finish all concrete surfaces so that they are smooth, square, and free of gaps greater than or equal to 3/32-inch through which media could escape.

D. The CONTRCTOR shall provide all lubricants and other supplies required for equipment startup and adjustment.

E. The CONTRACTOR shall provide all support beams and/or slabs, platforms, grating, floor plate, handrails, and platforms as shown on Contract Drawings.

F. The CONTRACTOR shall provide all labor, supplies and utilities as required for startup, adjustment and performance testing, with the exception of sampling and analysis labor and equipment provided by OWNER.

G. The CONTRACTOR and MANUFACTURER shall assist the OWNER with process startup activities. The CONTRACTOR shall be responsible for the placement of seeded and unseeded media, temporary pumping and piping systems, and temporary heating as required by the MANUFACTURER. The OWNER will operate the process during startup and performance testing.

H. The CONTRACTOR shall supply and install all panels and variable frequency drives (VFD's) in compliance with Section 16480 – Variable Frequency Drives and as shown on the Contract Drawings, unless otherwise noted.

I. The CONTRACTOR shall install all control panels and instrumentation provided by the MANUFACTURER in compliance with Division 17.

J. The CONTRACTOR shall supply and install all electrical power, control wiring and conduit to the MANUFACTURER supplied equipment, including wire, cable trays, cable, junction boxes, fittings, disconnects, conduit, etc. in compliance with Division 16.

K. The CONTRACTOR shall coordinate with the MANUFACTURER on all interface points such as piping and electrical tie-ins. Unless otherwise noted in the specifications or on the drawings, equipment to connect interface points shall be the responsibility of the CONTRACTOR.

1.07 SUBMITTALS

A. Submittals shall be in accordance with Section 01300 –Submittals and Section 11000 – Equipment General.

B. Shop Drawings: In addition to the shop drawing information required elsewhere, the following items shall be submitted:

1. Installation instructions on all equipment including, but not limited to, aeration equipment, mixers, air lift pumps, instruments, media retention screens, etc.

2. Controls narrative for the purpose of integrating controls with filtrate feed, equalization, and effluent transfer systems.

3. Literature and drawings describing the equipment in sufficient detail including dimensions and materials of construction to indicate full accordance with the Specifications.

4. Calculations confirming that the equipment furnished meets all design criteria and the intent of the Contract Documents including aeration demand calculations, mixing energy calculations, and surface area removal rate calculations. All aeration calculations shall be submitted for the minimum, average, and peak loadings as listed in Section 2.

5. Hydraulic calculations confirming that there is less than 3-inches of headloss through the media retention screens under peak flow conditions (as listed in Section 2).

6. Calculations showing all mixer and impeller design information (stresses, critical speed, deflections, shear, impeller power draw at specified speed, and pumping capacity at specified speed of the impeller).

7. Calculations for mixer gear and bearing life.

8. Structural design calculations for the mixer mounting devices.

9. Anchor calculations for aeration diffuser grid.

10. Calculations and/or literature confirming that all components within the gear reducer will receive adequate lubrication.

11. Data on the characteristics, features, and performance of the equipment.

12. The total weight of the equipment including the weight of the single largest item.

13. Motor drive data.

14. Welding Fabrication Procedure

C. Certifications: Furnish affidavits from the mixer MANUFACTURER stating that the mixers have been properly tested and are ready for full-time operation. Certification of Performance Test and vibration report required.

1.08 QUALITY ASSURANCE

A. All equipment furnished under this specification shall be new and unused, unless otherwise noted in this specification (exception is the seeded media).

B. Refer to Section 01400 – Quality Control Services.

C. The CONTRACTOR shall assume responsibility for the satisfactory installation and assisting the OWNER with initial startup of the entire MBBR Deammonification system.

D. The installations shall conform to all applicable codes that are typical and reasonable for the type of installation.

1.09 DELIVERY STORAGE AND HANDLING

A. The CONTRACTOR shall be responsible for receipt, protection and storage in accordance with Section 01600 –Materials and Equipment, and the MANUFACTURER's recommendations of all items shipped to the site from the time of delivery until installation is completed and the units and equipment are ready for operation. The equipment shall be suitably covered and protected at all times. Sufficient blocking shall be provided to prevent noticeable sagging of stored materials between supports and to prevent permanent distortion of the equipment. No iron or steel a shall be allowed to come into contact with stainless steel components during handling and storage of the equipment. The CONTRACTOR shall follow the MANUFACTURER's instructions to exercise any stored rotating equipment.

B. The CONTRACTOR shall coordinate phased delivery of the unseeded media with the MANUFACTURER so that the media is not being stored on site upon delivery for more than 72 hours upon arrival.

C. The CONTRACTOR shall coordinate the delivery of the seed media with the MANUFACTURER so that the seed media can be installed within eight (8) hours of arrival onsite immediately into the deammonification reactor that is being aerated and is receiving centrate at the time of delivery. All equipment shall be tested and all virgin media received before seeded media is shipped. Any shipping delays within the MANUFACTURER'S control that impact the seed media prior to arrival and unloading at the Hornsby Bend Biosolids Management Plant and result in additional costs shall be by the MANUFACTURER up to 10 percent of the Contract Value. Any impacts to the seed media after unloading that result in additional costs shall be by the CONTRACTOR.

1.10 WARRANTY

A. The MANUFACTURER shall guarantee the equipment, including media, controls, mixers, appurtenances and instrumentation, for two (2) year after notice of substantial completion for the ARF, with a warranty against all defects in workmanship and materials.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Prior to start-up, MANUFACTURER shall furnish complete operations and maintenance manuals in accordance with Section 01730 – Operation and Maintenance Data. The manuals shall be prepared specifically for this installation and shall include all required descriptions, and other information that is required to instruct operation and maintenance personnel unfamiliar with such equipment.

1.12 SPARE PARTS

A. The MANUFACTURER shall submit a list of suggested spare parts for the mixers, motors and drives, and a listing of the price for each spare part. Spare parts may then be purchased by the OWNER directly from the MANUFACTURER and outside of the scope of these Contract Documents.

B. Reference specification Sections 17100, 17200, and 17600 for required instrumentation and control system spare parts.

1.13 PATENTS

A. The MANUFACTURER shall indicate if any patents or licenses are involved because of equipment furnished, or process employed. License fees or royalties required in connection with use of the MBBR Deammonification System shall be included in the Contract Price for the life of the equipment. The MANUFACTURER shall assume all costs of patent fees or licenses for equipment or processes, and shall defend and save harmless the CONTRACTOR, OWNER and ENGINEER and their agents from

damages, judgments, claims and expenses arising from license fees or claimed infringements or any letters of patent or patent right, or because of royalty or fee for the use of any equipment or process, structural feature or arrangement of any of the component parts of the equipment supplied by MANUFACTUERER when operated and maintained as instructed by MANUFACTURER; and the price stipulated for all such patent fees, licenses, or other costs pertaining thereto.

1.14 PROCESS PERFORMANCE GUARANTEES

A. The ammonia removal performance of the MBBR Deammonification system will be demonstrated via one (1) thirty (30) day performance test during the first twelve (12) months of operation, following stabilization of the process. The performance test will demonstrate that the MANUFACTURER has complied with the effluent quality criteria specified herein.

B. Guaranteed Performance is based upon a process designed in accordance with the influent and effluent wastewater criteria from Section 2.

C. Additionally, the following conditions shall be met by the OWNER:

1. There will be sufficient alkalinity, either present in the wastewater or by means of chemical addition. The OWNER shall be responsible for the cost and labor of any chemical addition required for startup.

2. The wastewater being reasonably biodegradable with no inhibitory concentrations of toxic compounds present.

D. The MBBR deammonification process shall meet the following guaranteed percent removals at average loading conditions, as indicated in Section 2:

Parameter	Units	Required Performance (30-day average)
Ammonia (NH_4-N) Oxidation (mg/L)	%	≥ 80
Total Inorganic Nitrogen (TIN) Reduction (mg/L)	%	≥ 70

Notes:

1. The running 7-day average reactor temperature shall not be lower than the minimum process water design temperature (77°F) or greater than 95°F, and any daily average ambient temperature shall not be less than 37.4° F.

2. The 7-day average applied loads shall not exceed the design loadings (calculated based on the maximum month design flow and average concentration) by more than 10 percent. The 30-day average applied loads shall not exceed the design loadings.

3. The 7-day average NH_4-N concentration in the filtrate shall not be less than 600 mg/L and the average over the test period shall not be less than 630 mg/L.

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Veolia Water Technologies, Inc.

2.02 MBBR DEAMMONIFICATION SYSTEM DESIGN CRITERIA

A. The MBBR Deammonification System design shall be based on the equalized flow and load conditions summarized in the table below. The MANUFACTURER shall provide all equipment and components necessary to achieve future design with this phase of work, except for the media fill. The floating media fill shall be provided for only the Initial Values and Future Values will be met with additional fill installed in the future.

Parameter	Units	Initial Value	Ultimate Value
Flow, Average	MGD	0.79	1.05
Flow, Maximum Month	MGD	0.87	1.16
Flow, Peak	MGD	0.92	1.23
NH_4-N, Average	mg/L	630	
TSS, Average	mg/L	500	
COD, Average	mg/L	530	
Alkalinity (as $CaCO_3$), Average	mg/L	2,520*	
Temperature, Minimum/ Maximum	^oC	25 / 40	
pH, Average	s.u.	7.9	
Ammonia Oxidation	%	90	
Total Inorganic Nitrogen Removal	%	80	

*Required alkalinity is 2,000 mg/L based on the average influent TKN concentration

of 630 mg/L and 80 percent ammonia oxidation.

B. Process aeration shall be provided by three (2 duty and 1 standby) new positive displacement blowers provided by the CONTRACTOR. Refer to Section 11376 – Positive Displacement Blowers.

C. The MBBR Deammonification System shall be designed for operation in the Ammonia Treatment Reactors as indicated on the Drawings. Equipment shall be designed for the following:

Parameter	Units	Initial Value	Future Value
Number of Reactors	-	2	2
Reactor Dimensions (Each)	ft	80 L x 60 W x 19.5 (SWD)	
Total Reactor Volume (All Trains)	ft^3	187,200	
Type of Biofilm Carriers	-	K5	
Fill of Biofilm Carriers, All Reactors	%	36.3	48.5
Total Bulk Volume of Carriers	ft^3	68,042	91,747
Aeration System Type	-	Medium Bubble	
Depth of Diffuser Submergence	ft	18.5	
Design Residual D.O. Concentration	mg/L	1.5	
Actual Oxygen Required (AOR), Average Flow	lb-O_2/hr	317	421
AOR, Max Month Flow	lb-O_2/hr	349	465
Total Standard Oxygen Transfer Efficiency at 19.5 ft SWD	%	20.4	
Total Air Requirement, Ave Load	SCFM	3,460	4,600
Total Air Requirement, Max Month Load	SCFM	3,770	5,030

2.03 MBBR EQUIPMENT

A. BIOFILM CARRIERS (MEDIA)

1. The MANUFACTURER shall provide AnoxK^{TM}5 (K5) carrier elements.

2. ENGINEER or OWNER may reject media if field inspection during final placement of the media reveals non-conformity in terms of media shape, size, or stock material integrity.

3. Virgin media shall be contained in bags. The media in each bag shall be of known volumetric quantity such as to facilitate accurate inventory control during final placement of the media. Each bag shall have handles on the topside to assist in moving the bags from the storage location above the basins for final placement of the media.

4. Seed media shall be contained in 275-gallon totes or other suitable waterproof container. Installation of the unseeded and seeded media shall be the responsibility of the CONTRACTOR.

5. The CONTRACTOR shall install the media into the reactors and maintain an accurate inventory of the number of bags installed in each reactor. These records shall be made available to the OWNER, ENGINEER or MANUFACTURER upon request.

6. The MANUFACTURER shall provide 68,042 cubic feet of media for the MBBR system of which at least 5 percent (3,402 cubic feet) of the supplied media shall be "seeded" with anammox bacteria. The seeded media shall be equally divided into the two Ammonia Treatment Reactors.

7. Media material shall be an extruded, white, virgin high-density polyethylene. Recycled materials will not be accepted.

8. The nominal density of the media in bulk is 7.5 lb/ft3. The nominal specific gravity of the media shall be 0.95. Nominal effective surface area for K5 media in bulk for biomass growth is 800 m2/m3. The diameter shall be 25 mm with a height of 3 to 4 mm.

B. AERATION SYSTEM (MEDIUM BUBBLE)

1. General: The CONTRACTOR shall install aeration grids in the basins as shown on the Contract Drawings and specified herein. The MANUFACTURER shall furnish the items listed below:

   a. Drop pipes and in–basin manifolds as indicated in the Contract Drawings

   b. Aeration grids and assemblies

   c. Supports and anchors

   d. All stainless steel components shall undergo passivation/pickling in

accordance with the requirements specified in Section 15023 – Stainless Steel Piping and Tubing and Section 05015 – Stainless Steel Fabrications.

2. Drop Pipe: 316/316L stainless steel drop pipes shall be provided for the aeration grid(s) to connect to the air supply piping as shown on the Contract Drawings. The drop pipe shall be schedule 10 and be connected to the air supply piping. The MANUFACTURER air piping scope of supply ends at the top of the drop legs with a new 316 stainless steel flexible coupling. The in-basin manifolds, piping, and pipe supports shall be provided by the MANUFACTURER. CONTRACTOR shall be responsible for all piping from the top of the drop leg 316SS flex coupling back to the blowers.

    a. Aeration Grids:

        1) 316/316L stainless steel aeration grid(s) shall be provided for the basins as shown on the Contract Drawings. The aeration grids shall be comprised of an aeration grid manifold of Schedule 10 pipe with 1-1/4-inch diameter laterals of Schedule 5 pipe. The laterals shall be uniformly spaced along the length of the aeration grid manifold. Each lateral will have a series of 4mm (5/32-inch) holes uniformly spaced along the bottom. The lateral pipe shall include a crimped drop pipe at the end, to provide for easy drainage, and to prevent entry of media. Each aeration grid shall be supplied with all necessary couplings and hardware.

        2) The CONTRACTOR is responsible for field verifying the existing basin floor elevations and providing the information to the MANUFACTURER prior to the submittal.

        3) Straub flexible couplings used to connect aeration grid piping sections. Weld beads will be applied to the aeration grids to prevent the couplings from migrating.

    b. Supports:

        1) Drop Pipe Supports: MANUFACTURER shall provide all required supports. CONTRACTOR shall install all supports according to MANUFACTURER'S requirements.

        2) Aeration Grid and In-Basin Manifold Supports: Aeration grid and in-basin manifold supports to be fabricated from 316/316L stainless steel. Each support shall consist of a minimum 2-inch bearing contact between the pipe and support. The support shall be secured by two (2) 18-8 stainless steel threaded rods with a minimum diameter of 5/8-inch. Each rod will be anchored to the concrete by chemical anchors. The aeration grid and in-basin manifolds shall be secured to the support by a u-bolt to prevent lateral movement. Supports shall be

designed to allow for on-site height adjustment. Supports shall have a maximum spacing of 9'-0" and shall be per the MANUFACTURER's shop drawings. All interconnecting hardware required to secure the support to the aeration grid shall be provided by the MANUFACTURER. No field welding shall be required. In-basin manifolds, supports and hardware to be provided by the MANUFACTURER.

3) Aeration piping, grids, and supports shall all be design to carry the weight of the reactor's media, assuming wet media and maximum media fill.

c. Construction

1) Welding: All welding shall conform to MANUFACTURER Welding Fabrication Procedures and shall be in accordance with Section 05500 – Metal Fabrications. All factory welding shall undergo pickling/passivation to prevent rust and corrosion.

2) Bolting: Unless otherwise specified, bolts, screws, nuts, and washers shall be Type 316 stainless steel. All support nuts shall be double nutted to prevent potential disassembly associated with vibration in the piping.

3) Installation: The installation of the aeration equipment shall be such that upon completion of installation, all diffusers are level to ±1/8-inch of a common horizontal plane.

d. Design

1) The system shall be designed to be submerged within the tank basin without deforming any component and shall be designed to resist the forces from the top entry mixers.

2) All welded parts and assemblies shall be shop fabricated from 316/316L stainless steel with a 2D finish. Unless otherwise specified, all non-welded parts and pieces shall be shop fabricated from type 316/316L stainless steel with a 2D finish.

3) All flanged joints shall have 45 to 55 durometer, Shore A, EPDM gaskets.

4) All aeration grid and in-basin manifold supports shall be designed to compensate for a maximum floor elevation difference of ±3-inches.

5) All supports shall be designed to resist the load of the media and biofilm in the event the tank is drained.

C. CYLINDRICAL SCREEN ASSEMBLIES

1. The CONTRACTOR shall install two (2) cylindrical screens for media retention in each basin as shown on the Contract Drawings and specified herein. The MANUFACTURER shall furnish the cylindrical screens.

2. Cylindrical Screen (Media Retention Sieve): 316/316L stainless steel cylindrical screens shall be provided for each reactor as shown on the Contract Drawings. The cylindrical screens shall be constructed of a minimum 14-gauge sheet and have a perforation pattern of a 5/8-inch dia. with 13/16-inch centers, on a staggered spacing. Each screen will have a minimum ¼-inch thick plate mounting flange with two sets of anchor holes for wall mounting.

3. Construction

    a. Welding: All welding shall conform to MANUFACTURER Welding Fabrication Procedures and shall be in accordance with Section 05500 – Metal Fabrications.

    b. Bolting: Unless otherwise specified, bolts, screws, nuts, and washers shall be 316 stainless steel and supplied by the MANUFACTURER. Anchor bolts shall be in accordance with Section 05500 – Metal Fabrications.

    c. Installation: Each cylindrical screen shall be direct wall mounted as required by the MANUFACTURER. The installation of the cylindrical screen shall be such that upon completion of installation, all cylindrical screens are level to ±1/8-inch of a common horizontal plane.

4. Design

    a. The system shall be designed to be submerged within the tank basin assuming the maximum allowable media fill without deforming any component.

    b. All welded parts and assemblies shall be shop fabricated from 316L stainless steel with a 2D finish. Unless otherwise specified, all non-welded parts and pieces shall be shop fabricated from type 304 stainless steel with a 2D finish.

    c. There shall be less than 3-inches headloss through the cylindrical screens under peak flow conditions.

D. TOP ENTRY MIXERS

1. General

    a. The CONTRACTOR shall provide the mixer bridges and install the top entry mixer(s) in the reactors as shown on the Contract Drawings and specified herein. The MANUFACTURER shall furnish

the mixers as specified herein and in accordance with Section 11210 – Vertical Shaft Mixers.

b. Mixers shall be of the non-clogging, vertical shaft, hyperboloid-body type.

c. The mixer and its appurtenances shall be specifically designed for continuous duty operation in a submerged application in the MBBR Deammonification reactors filled with the K5 Media. The mixers shall not overload the motors at any point within the operating limits recommended by the mixer manufacturer.

d. The mixer shall be designed with no submerged bearings and with a dry installed motor. The entire weight of the mixers shall be supported by concrete bridges/walkways provided by the CONTRACTOR.

e. Qualifications of Manufacturer: The manufacturers shall be experienced in the design and construction of equipment for this purpose and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than three (3) years.

f. Acceptable Manufacturers:

1) Veolia AnoxKaldnes / Invent Environmental Technologies, Inc

2. Design: The mixers shall be capable of mixing each MBBR reactor as required by the design conditions and performance tests outlined below.

No. of mixers	Two (2) per reactor
Mixer configuration	Hyperbolic
Model	HCM/2500-40-29.5
Liquid being mixed	Mixed liquor With AnoxKaldnes Media
Media Type	AnoxK 5
Percent Fill	Up to 50% (at Ultimate condition)
Speed	39.6 RPM
<u>Mixing Zone</u>	
Depth	19.5 ft
Length	80 ft
Width	60 ft
Motor Horsepower	29.5 Hp

Mixer Diameter	98.4 inches
Pitched Blade Diameter (cyberprop)	71 inches (1.8 m)
Motor Type	Squirrel Cage, Induction type
Nominal Motor Speed	Coordinate with Mixer RPM Requirements
Motor Efficiency	NEMA MG1 Premium Efficiency
Design	Design B
Duty	Continuous
Insulation	Class F
Voltage	460V, 3 Ph., 60 Hz
Service Factor	1.15 (The motor service factor shall not be used in sizing the motors)

a. Each mixer assembly shall consist of a dry installed heavy-duty speed reducer with hollow shaft, variable speed premium efficient electric motor, baseplate, 316-SS shaft, and upper 4-blade propeller and composite lower hyperbolic mixer body.

b. The bottom of the hyperbolic mixing body should not exceed 12” above the basin floor.

c. During operation the mixer should not generate any upward forces on the bridge construction. The mixer should have a steady stationary flow pointed downward parallel to the mixer shaft. The highest speeds and turbulent fluctuations should be produced in the bottom area.

d. The gear drive assembly for each mixer shall consist of parallel-shaft helical gearbox and motor as designed by SEW Eurodrive. The mixer gear drive must be built in accordance with the current AGMA Standards. The AGMA calculated drive HP rating shall be stamped on the drive nameplate. Drive housings shall be of high quality close grained cast iron, or fabricated steel, stress relieved and reinforced, and shall be provided with lifting lugs.

e. Each unit shall be provided with an integral or separate baseplate and shall have a minimum 12” ductile iron pedestal base (provided by the MANUFACTURER) for ease of assembly of the agitator shaft and to facilitate draining of the oil from the gear drive.

f. Gearing must be vertical parallel shaft all helical gears or helical spiral bevel to ensure the highest efficiency coupled with the convenience of mounting and maintenance (worm gearing is not acceptable). Helical gears shall be a minimum AGMA Quality 10 per AGMA standard 390.03. Spiral/bevel sets shall be a minimum

AGMA Quality 8, matched and lapped. The gears shall be lubricated from a common oil bath. The full load operating noise levels of the mixer drives shall not exceed 85 dBA at 3 feet from any part of the drive assembly.

g. The mixer gear drive shall be designed with an output shaft system suitable for the loadings imposed by the specific duty. The drive's minimum AGMA service factor shall be 1.5 and based upon motor nameplate horsepower. The service factor shall be based on AGMA Standard 6010-F97 for 24 hour per day moderate shock application. Service factors based on uniform load and motor bhp will not be accepted. Agitator gear drive coupled to impeller shaft must be designed, manufactured, and tested by the mixer supplier. Furnishing second party gear drives will not be allowed.

h. All drive bearings shall be of the antifriction type, ball or roller bearings. All bearings within the drive, including output shaft bearings, shall have minimum AFBMA B-10 lives of 50,000 hours when operating at full motor nameplate horsepower at design speed.

i. Each drive must have an effective lubrication of rotating elements without leakage down the output shaft. Output shaft bearings may be grease lubricated. Output shaft bearing seals shall be dry-well type. Lip seals shall not be permitted.

j. The electric motor drivers shall have a 1.15 service factor and TEFC/TENV enclosure with class F insulation and class B temperature rise above 104 °F ambient. The motors shall be squirrel cage induction motors for operation on 3 phase, 60 hertz, 460V with synchronous speed of 1800 RPM or less. Motors shall be variable speed, premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. Maturation mixer motors are to be used with AC inverters that shall meet NEMA MG1, part 31 for variable torque, 10:1 turndown operation. The motor shall be connected to the input shaft with a flexible coupling and shall be pilot mounted with a NEMA C face flange. Integral mounted motors without flexible coupling attachments shall not be accepted. IEC or other non-NEMA motor flanges will not be accepted. All motors shall be designed constructed and tested in accordance with applicable IEEE, NEA, and ANSI, standards.

k. The lower mixer shaft shall be connected to the upper, or drive output shaft, by means of a rigid flanged or integral coupling.

l. The agitator shaft shall be of solid 316 stainless steel construction. The shaft shall be designed such that the combined (Mohrs circle) maximum shear stress shall not exceed 9,000 psi under maximum operating loads for stainless steel. It shall be of overhung design for use in complete coverage (liquid levels at least one impeller

diameter above the impeller height). The use of underwater steady bearings is not permitted. The mixer shaft shall have a maximum operating speed of 0.75 times the natural frequency of the shaft and impeller assembly without the use of stabilizing ring and lower shaft bearing.

m. Mixer hyperboloid shall be manufactured of FRP and be a streamlined stress-free body without any mounted or fitted parts. The transport ribs which accelerate the flow shall be integrated in the mixer body. The mixer body shall be coated with a gel coat to provide a polished surface. The hyperboloid mixer shall have laminated stainless steel insert nuts.

n. Spare Parts: MANUFACTURER shall include one set of rubber buffers and one shaft holder for each mixer provided, all lubricating oils required for one full year of operation (prefilled). Spare parts shall be identical to and interchangeable with similar parts installed.

o. Upon installation each unit shall be run to demonstrate its ability to operate without overloading, jamming, or excessive vibration during normal operation.

p. All non-wetted parts will be shipped with MANUFACTURER's standard factory paint, suitable for use as a finish coat in accordance with Section 09960 – High-Performance Coatings. All touch-up and additional coats are to be applied in the field by the CONTRACTOR. Wetted parts, of 304 or 316 stainless steel, will not be painted.

q. The MANUFACTUER shall provide 316 stainless steel anchor bolts, nuts, and washers, and furnish templates necessary for setting the equipment. Placement of the anchor bolts shall be performed by the CONTRACTOR from certified dimension prints supplied by the MANUFACTURER. Anchor bolts shall be in accordance with Section 05500 – Metal Fabrications.

r. The mixers shall be as manufactured by Invent Environmental Technologies, Inc. and shall be sized to provide adequate mixing energy based on a maximum media fill of 50 percent of the deammonification basin volume.

3. Execution

4. Factory Test: The mixer MANUFACTURER shall perform inspections and tests on each unit before shipment. Hyperbolic mixer body diameter, motor rating, and electrical connections shall be checked for compliance with contract requirements. The following tests shall be performed on the SEW gearmotors:

a. One-second-high potential test

b. No-load run test including no-load current, no-load speed, phase deviation current and no-load motor power.

c. Visual inspection of the unit.

d. Tester shall inspect for any abnormal noise.

e. Certified copies of all test procedures and results shall be provided to the ENGINER prior to shipment.

f. Startup and Testing: Prior to the start of the mixer tests, fill the zones to the maximum water elevation with test water (plant effluent).

1) Run the mixer for one hour at maximum design conditions. Demonstrate for each mixer:

2) Is free of overheating of any parts.

3) Is free of all objectionable vibration, in accordance with manufacturer's recommendations.

4) Is free of overloading of any parts.

5) Via the Control Station(s), verify mixer functions.

6) Record amperage draw.

7) Continue operating the mixer for 24 hours without overheating, excessive vibration or overloading.

8) Certified copies of all test procedures and results shall be provided to the Engineer.

E. AIR LIFT PUMPS

1. General: The MANUFACTURER shall supply AnoxKaldnes air lift pump assemblies complete with mounting brackets, Type 316 stainless steel anchor bolts, washers, nuts and lifting chain. The air lift pump assemblies shall be Type 316/316L stainless steel. The CONTRACTOR shall install and connect aeration supply to the air lift pumps as shown on the Contract Drawings.

2. Each air lift pump shall draw water from the MBBR deammonification reactor to be spread on the reactor water surface to reduce surface foam.

3. MANUFACTURER shall design and supply orifice plates, tubing and small diameter valves to feed air to the airlift pumps.

4. CONTRACTOR shall supply aeration piping, expansion joints and valves to air lift pumps as shown on the Contract Drawings. CONTRACTOR shall include Type 316 stainless steel supports as indicated on the Contract Drawings and shall provide expansion couplings as indicated to account for thermal pipe expansion.

5. CONTRACTOR shall secure fasteners for all airlift pump supports with nylon lock nut connections to prevent vibration from disassembling the fasteners.

F. ANCHORS

1. The MANUFACTURER shall size and furnish all anchoring hardware for the supplied equipment – refer to Section 05500 – Metal Fabrications.

2. The CONTRACTOR shall furnish all epoxy and dispensing equipment for chemical anchoring. The epoxy shall be Hilti H-200 adhesive or similar epoxy anchor product.

G. MANUAL AIRFLOW ISOLATION VALVES

1. The MANUFACTURER shall furnish nine (9) manual butterfly valve for each reactor– refer to Section 15202 – Butterfly Valves.

2.04 BLOWERS

A. Blowers shall be provided by the CONTRACTOR. Blowers shall be designed to meet the required aeration demand for the MBBR Deammonification System including diffuser grids, airlift pumps, and other components of the system requiring forced air. Refer to Section 11376 – Positive Displacement Blower

2.05 INSTRUMENTATION AND CONTROLS

A. The requirements in Division 17 are applicable to this section.

B. Control Strategy: The MANUFACTURER shall submit a complete set of control strategies including all proprietary process control strategies which depict all monitoring and control functions on a loop by loop basis. Refer to Section 17900 – ARF Control Narrative and associated CP Appendix.

C. Refer to Section 17100 for required network coordination and graphics meeting with the owner and system integrator.

D. Vendor Control Panel

1. The MANUFACTURER shall provide a PLC-based control panel to monitor and control the MBBR Deammonification process. The PLC-based control panel shall include the PLC, operator display, control

relays, push buttons and selector switches, indicating lights, power supplies, incoming power surge protector, analog isolators, signal conditioners, circuit breakers, and terminal strips as described herein and on the contract drawings.

2. Configuration and programming of the MANUFACTURER'S PLC and the OIU shall be by the MANUFACTURER.

3. The CONTRACTOR shall furnish and install all required equipment, including signal wiring, piping, terminations, incidental conduits, and necessary mounting and accessory equipment to provide a complete and operational system.

4. The CONTRACTOR will terminate all wiring within instrument cabinets at terminal blocks.

5. The MBBR Deammonification Control Panel shall be located in the new Blower Building and shall be supplied in a NEMA 12 carbon steel enclosure suitable for indoor use. The front panel of the cabinet shall contain operator interface and push buttons, as detailed within this specification. The Schneider Electric Modicon PLC based control panel shall also include an operator interface display mounted on the front of the control panel. The internal portion of the cabinet shall contain all rack mounted PLC equipment, power supply, processor and interface cards. Relays, terminal strips and surge suppressors shall also be contained within the cabinet. Terminal strips for all field wiring shall be furnished within the panel. Refer to the network block diagram for additional equipment supply an d connectivity details.

    a. The MANUFACTURER shall include an uninterruptible power supply capable of operating the MBBR PLC for no less than 10 minutes within the PLC panel.

    b. The MANUFACTURER shall provide a Schneider Modicon M580 controller that is compliant with OWNER standard.

    c. Redundant processors are not required.

    d. The MANUFACTURER shall provide a panel mounted 15" Operator interface unit (OIU), Schneider Electric Harmony GTU HMIDT732, with the latest Vijeo Designer software.

        1) The Manufacturer shall coordinate with the ICS (Instrument and Control System Contractor) the required OIU graphics development requirements. At a minimum, the Manufacturer shall utilize the Owner's standards for representation of equipment status, alarms, tagging, naming convention, and entry and view fields for consistency in operational interpretation.

        2) Allowance shall be made to attend a network and graphics

coordination meeting with the ICS as described in section 17100. Graphics submittal shall be as described in section 17900.

e. Coordinate with the Owner for required network equipment IP addresses.

6. An alarm horn shall be provided loose with the Control Panel. The CONTRACTOR shall mount this horn adjacent to the Control Panel. The horn shall be manufactured by Federal Signal or an approved equivalent. A horn disconnect switch/circuit breaker shall be provided inside the Control Panel.

7. The MANUFACTURER shall supply a PLC I/O list as a required element of the PLC system design. The format for PLC I/O list is an OWNER standard in order to align with other plant data systems.

8. The MANUFACTURER shall supply functional requirements documentation, program organization diagrams, control logic descriptions, and logic diagrams as necessary to thoroughly document the system program. Final PLC program and OIU control screens shall be separately furnished on a secured USB to the Owner for Owner use. Installed PLC programs and OIU screens shall not be password protected.

9. Remote access to the vendor control panel will be prohibited.

E. Flow Control Valves

1. The MANUFACTURER shall supply two (2) air flow control valves to control airflow to each reactor in accordance with Section 15201 Actuators for Process Valves and Gates and Section 15202 Butterfly Valves.

F. Field Instrumentation

1. Thermal Mass Flow Meter

a. The MANUFACTURER shall supply two (2) thermal mass flow meters to measure airflow to each reactor in accordance with Section 17102 Flow Measuring Systems.

2. Dissolved Oxygen (DO) Probes

a. The MANUFACTURER shall provide two (2) DO probes (one per reactor).

b. The interface unit shall convert the sensed dissolved oxygen concentration to an analog electrical signal.

c. The wetted probe shall sense the dissolved oxygen concentration

via a luminescent sensor. The signal from the sensor shall be tied to the interface unit that will convert the sensor signal to a 4 to 20 mA signal that will interface with the PLC. The dissolved oxygen transmitter shall be utilized for monitoring the dissolved oxygen concentration in the tank.

d. The measuring principle shall be based on luminescent material that is sensitive to oxygen.

e. Sensor replacement shall not require factory service personnel to be present. Calibration shall be accomplished in free air and will not require special chemical baths.

f. The interface transmitter shall be housed in a NEMA 4X/IP66 enclosure with a corrosion-resistant finish.

g. Operation characteristics

1) The dissolved oxygen probe shall be a continuous-reading probe that utilizes luminescent sensor technology.

2) The probe will not require calibration more frequently than once every six months.

3) The measurement range shall be 0.00 to 20.00 mg/L dissolved oxygen.

4) The operation of the analyzers shall not be affected by H2S, pH, K+1, Na+1, Mg+2, Ca+2, NH4+1, Al+3, Pb+2, Cd+2, Zn+2, Cr (total), Fe+2, Fe+3, Mn+2, Cu+2, Ni+2, Co+2, CN-1, NO3-1, SO4-2, S-2, PO4+3, Cl-1, anion active tensides, crude oils, or Cl2.

5) The probe shall provide electrolyte-free operation without the requirements of sample conditioning.

h. The probe shall be furnished with a mounting kit.

i. The analyzer shall be HACH LDO® 2 Probe and sc4500 Controller interface unit.

3. Float Switch

a. MANUFACTURER shall provide two (2) float switches (one per reactor) in accordance with Section 17370 – Mechanically Activated Level Switches.

4. Combination pH/Temperature Probe

a. The MANUFACTURER shall provide two (2) pH/temperature probes (one per reactor).

b. The pH sensor shall be of Differential Electrode Technique design which uses two electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.

c. The sensor shall have a measuring range for pH of 0.00 to 14.00.

d. The sensor shall be manufactured by Hach, model number DPD1P1.

e. The microprocessor-based transmitter shall accept any Hach Differential Technique Digital or Analog pH or ORP sensor or any conventional combination electrode.

f. The transmitter shall be NEMA 4X rated, 120VAC and shall offer two 4-20mA output signals.

g. The transmitter shall be Hach model sc4500.

5. Ammonia Analyzer

a. The MANUFACTURER shall provide two (2) ammonia analyzers (one for the influent/EQ and one for reactor pair) and three (3) sampling mechanisms (one influent/ EQ and one for each reactor) for analyzing the ammonia in process water

b. The method of measuring ammonium will be by gas selective electrode (GSE) that uses liquid to gas- phase conversion.

1) Sample is mixed with sodium hydroxide that converts ammonium to ammonia which is expelled from the sample.

2) The ammonia gas can pass the gas selective membrane.

3) Ammonia changes the pH of the electrolyte and the electrode then measures the pH value and calculates the ammonium concentration.

c. Performance Requirements

1) Measurement range (depending on model/range selected):

a) 10 to 1000 mg/L

2) Lower detection limit (depending on model/range selected):

a) 10 mg/L

3) Accuracy (depending on model):

a) 3% ±0.05 mg/L, or

b) 3% ±1.0 mg/L, or

c) 4.5% ±10 mg/L

4) Reproducibility (depending on model/range selected):

a) 2% ±0.05 mg/L, or

b) 2% ±1.0 mg/L, or

c) 2% ±10 mg/L

5) Response time: Less than 5 minutes (T90), including sample preparation (in combination with Hach Filterprobe sc)

6) Measurement interval: 5 to 120 minutes, adjustable

7) When connected to a multi-parameter digital controller the overall status of the instrument performance is displayed as a percentage value via a measurement indicator

8) When connected to a multi-parameter digital controller the overall time remaining until maintenance tasks are due is displayed in days

9) Operational Criteria

a) Sample temperature: 39 to 104 °F (4 to 40 °C)

b) Sample pH: 5 to 9 pH

c) Operating temperature: - 4 to 114 °F (-20 to 45 °C)

d) Operating humidity: 95% relative humidity, non-condensing

d. CE conform. Listed to UL and CSA safety standards by TUV.

e. The product shall include a one-year warranty from date of shipment.

f. Manufacturer: Hach , Model NH6000 sc Ammonium Analyzer.

1) Housing: ASA UV-resistant, IP55-rated, lockable

2) Gas sensitive electrode

3) Colorimeter

g. Equipment

1) The analyzer calibrates and cleans itself automatically.

2) The analyzer is equipped with self-diagnostic routines.

3) The required power supply is 115 Vac/50-60Hz connected to a Hach model sc4500 universal controller.

4) Data transmission is made with a data cable with the controller.

5) Outputs include relay, current outputs, and bus interface via the controller

6) Integrated sample pump for the FX620

h. Components

1) Standard Equipment: Analyzer, Manual, Reagents

2) 21.3 x 28.3 x 15.4 inches (540 x 720 x 390 mm)

3) Weight: 68 pounds (31 kg)

i. Accessories

1) Hach FX620 Sampling System

2) Filtrax Sample Filtration Systems and associated

3) Hach sc4500 controller

4) Mounting kits (stand)

2.06 REACTOR WALL QUALITY

A. CONTRACTOR shall be responsible for finishing, refinishing, filling, patching, or otherwise creating a smooth surface on the reactor floor and walls. Finish quality shall comply with ACI 301 Subsection 5.3.3.3.c SF-3.0.

PART III - EXECUTION

3.01 GENERAL

3.02 PREPARATION

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. General installation requirements shall be in accordance with Sections 11000 – Equipment General.

B. Placement of the anchor bolts shall be determined by the CONTRACTOR from certified dimension prints supplied by the MANUFACTURER.

C. Bolts and nuts for securing guide rail shall be assembled with "never-seize" and shall be secured with stainless steel wire locks or stainless steel castellated nuts and cotter pins.

3.04 SYSTEM START-UP, TESTING, AND CERTIFICATION

A. In accordance with Specification Section 01650 – Facility Startup/ Commissioning and MANUFACTURER supplied startup procedures.

B. The PLC-based control system shall be Engineer witnessed factory tested and field tested as detailed in specification Section 17100-3.01, 4.01, and 5.01.

C. MANUFACTURER shall submit system start-up, testing, and certification procedures to the OWNER and ENGINEER a minimum of one twenty (120) days prior to startup for review and approval.

D. The MANUFACTURER shall provide thirty-two (32) days of service in not less than six (6) trips by a fully qualified factory service representative to inspect the installed equipment, assist the CONTRACTOR to start the equipment operation.

E. The OWNER shall conduct weekly conference calls with the MANUFACTURER to review performance data and provide guidance on any process modifications.

F. The MANUFACTURER, in conjunction with the CONTRACTOR shall inspect equipment furnished by the MANUFACTURER and provide certification on the installation. This certification shall be limited to the visual inspection and known quantitative aspects of the MANUFACTURER's equipment.

G. The MANUFACTURER shall provide the services of a factory trained representative to check and verify the PLC program functionality (Dry testing).

H. The MANUFACTURER shall configure, program and test the control system and provide a written control narrative for the system. Instrument manufacturer shall be responsible for providing field services for calibration purposes and assist in integrating the instruments into the PLC. The System Integrator shall be responsible for updating the existing SCADA HMI screens with the new processes.

I. Prior to filling the tank with any filtrate or media, CONTRACTOR shall conduct functional testing of diffuser grids. Grids shall be tested with non-potable water and run over the range of the minimum and maximum air ranges. CONTRACTOR shall slowly ramp up from the minimum flow range to the maximum. Test shall be run at the maximum air flow rate for a minimum of 2 hours. CONTRACTOR shall observe for any areas which are not functioning properly and correct any issues. Should any issues be detected, contractor shall repair the issues and restart the testing for the 2-hour duration. Contractor shall coordinate visual confirmation by

ENGINEER/ OWNER and provide documentation to OWNER upon successful completion of diffuser testing.

J. Instruments and other devices that require calibration and checkout will be carried out after the CONTRACTOR has the equipment installed and verified continuity. Instruments and devices shall be configured and demonstrated to function prior to start-up. A document indicating the set points and calibration shall be furnished by the MANUFACTURER for documentation records.

K. The CONTRACTOR shall furnish all MANUFACTURER-approved consumables, including oil and grease prior to operation of equipment. All consumables after substantial completion will be by the OWNER.

L. Operation, maintenance and installation manuals shall be provided for the supplied equipment – refer to Section 01300 –Submittals and Section 01730 – Operation & Maintenance Data for O&M manual requirements.

3.05 TRAINING

A. The MANUFACTURER shall provide on-site training to the OWNER plant personnel.

B. The MANUFACTURER shall supply two (2) training sessions. The first session shall be before start-up and will consist of two (2) days to cover different shifts of OWNER's staff. The second training session shall occur within 6 months of initiating startup and will also consist of two (2) days.

C. The training services shall comprise a qualified representative to instruct and train plant personnel in the proper startup, operation, shutdown, maintenance, repair and troubleshooting of the system. Mechanical equipment suppliers will also provide training on their specific equipment.

D. A training outline shall be submitted to the ENGINEER for approval including the credentials of the training staff.

E. The training shall include the following topics:

1. System walkthrough
2. Theory of the Process
3. System Design
4. Mechanical Components
5. Instrumentation
6. Process Control Functions
7. Optimum Operation

8. Troubleshooting

9. Hands-on use of the Control Interface

10. Question and Answer Session

3.06 PERFORMANCE TESTING

A. The MANUFACTURER shall be responsible for providing guidance to the OWNER on the performance test including submitting performance testing procedures for review by the OWNER and ENGINEER a minimum of sixty (60) days prior to the testing start date for approval.

B. CONTRACTOR shall be responsible for dedicating the appropriate number of staff to assist OWNER during the performance testing period. CONTRACTOR shall anticipate no less than four (4) months and no greater than eight (8) months of time for performance testing. Performance testing shall last no less than thirty (30) days and shall commence within fourteen (14) days of MANUFACTURER'S written approval that system stability has been reached.

C. The OWNER shall be responsible for conducting the performance testing per MANUFACTURER's test plan, for collecting all samples, for carrying out all laboratory tests and for keeping detailed records as necessary for determining whether the performance guarantees have been met. The records shall be retained until the performance guarantee has been satisfied or until expiration of the period during which the performance test is to be performed whichever occurs earlier, and such records shall include all daily log sheets, notes, sample inspections, and instrument charts produced in operation of the plant.

D. Upon successful completion of the Performance Test, MANUFACTURER shall execute and submit a performance test report and the Certificate of Performance Test Acceptance to the OWNER. The effective date for acceptance shall be the date the Performance Test was completed.

E. The performance test shall be subject to the following general conditions:

1. All volumes specified shall be measured by tank gauges or calibrated meters acceptable to the MANUFACTURER and corrected to 60 °F .

2. All analyses, data reduction or tests not otherwise specified shall be carried out by procedures approved by the ENGINEER. (The publication, Standard Methods for Examination of Water and Wastewater, most recent edition, shall be the primary procedure source unless a different source is agreed upon by OWNER and the MANUFACTURER.)

3. The CONTRACTOR shall furnish all materials, utilities, services and personnel as required to operate the MBBR reactors during the performance tests.

4. The CONTRACTOR and OWNER will notify the MANUFACTURER in writing thirty (30) days in advance of beginning the performance test.

F. The following are specific responsibilities of the MANUFACTURER and OWNER with respect to the performance test and guarantees:

1. The OWNER shall be obligated to carry out the performance test at such conditions and at such time as the MANUFACTURER may reasonably request (or MANUFACTURER and OWNER mutually agree) for purposes of determining whether guarantees are met. The time within which the performance test is to be carried out may be extended by the length of any period of down time required for correcting any failure or deficient performance.

2. The OWNER shall provide the labor required to obtain samples and measurements and shall pay for all laboratory analyses of the samples.

3. All laboratory analyses shall be performed by the OWNER.

4. If during the performance test it appears that the process guarantees are not being met, the MANUFACTURER shall have the right to have the MBBR reactors operated at such reasonable conditions as it may deem necessary or advisable for the purpose of determining the nature or cause of the failure of the plant to meet such guarantee, provided such operating conditions are in accordance with good engineering practice and OWNER'S operating rules enforced at the plant site. Thereafter, the MANUFACTURER shall have the right to make or have made such adjustments in order to meet such guarantee and the right to make or have made such alterations or modifications to the plant necessary to correct deficiencies in the process design basis as it deems necessary or advisable. Such alterations or modifications shall be subject to review and approval by the OWNER and implemented at no additional expense to the OWNER.

5. The following recordings shall be taken daily during the Performance Testing period using analyzed samples and recording points:

Sampling and Analyses During Performance Testing				
Parameter	Sample Type	Frequency	Influent	Effluent
Plant Flow, MGD	Continuous	Daily	X	X
TSS, mg/L	Grab or 24 hr Composite	3/week	X	X
COD, mg/L	Grab or 24 hr Composite	3/ week	X	
Soluble COD, mg/L	Grab or 24 hr Composite	3/week	X	
Total Kjeldahl Nitrogen (TKN), mg/L	Grab or 24 hr Composite	3/week	X	

NH_3-N, mg/L	Grab or 24 hr Composite	5/ week	X	X
NO_3-N, mg/L	Grab or 24 hr Composite	5/week	X	X
NO_2-N, mg/L	Grab or 24 hr Composite	5/week	X	X
Total Phosphate (PO4-P), mg/L	Grab or 24 hr Composite	3/ week	X	X
Alkalinity, mg/L as $CaCO_3$	Grab or 24 hr Composite	3/week	X	X
Dissolved Oxygen (DO), mg/L	Continuous	Daily		X
pH, SU	Continuous	Daily	X	X
Temperature, ^0C	Continuous	Daily	X	X

6. The MANUFACTURER and OWNER will jointly review performance of the process system to determine compliance with performance guarantees. Review will include, but not be limited to, a comparison of influent and process design basis with the actual performance results.

7. The OWNER will promptly notify the MANUFACTURER of the failure to meet any process guarantee and specify the respect in which such guarantee has not been met.

8. If the MANUFACTURER disputes any claimed failure, notice of such dispute shall be furnished promptly to OWNER.

9. The MANUFACTURER shall not be responsible for non-fulfillment of guarantees or the cost of alterations or modifications to the plant due to deficiencies in the MBBR reactors beyond MANUFACTURER's control, such as the design by the ENGINEERS, materials or equipment, workmanship (other than that of the MANUFACTURER) or services beyond the control of the MANUFACTURER, including, but not limited to:

    a. Defective materials or mechanical conditions or deficient performance of equipment utilized in parts auxiliary to the technology not supplied by the MANUFACTURER.

    b. Noncompliance with the process design basis for said plant and/or noncompliance with operating instructions, or reasonable revisions of either of these consistent with the Specifications, furnished or approved in writing by the MANUFACTURER to OWNER or defective conditions or performance of any materials, equipment or work supplied by or contracted for by OWNER, other than those provided or supplied by the MANUFACTURER, provided that the MANUFACTURER has given OWNER notice of such noncompliance or defective conditions or performance promptly upon discovery of the same.

    c. Failure of OWNER to furnish adequate utilities such as, but not

limited to electricity, air, water, etc., as set forth in the O&M Manual supplied by the MANUFACTURER: an adequate operating staff; or mechanical failure of any of the equipment or component parts thereof due to ordinary wear and tear.

d. Failure of OWNER to perform any of the responsibilities and obligations assumed by it in accordance with the provisions hereof.

e. The failure of the OWNER substantially to comply with any or all of the foregoing conditions which impairs the MANUFACTURER'S ability to satisfy its guarantee shall constitute a waiver of the requirement of performance test to which such conditions are applicable and thereupon the MANUFACTURER guarantees relating to such tests shall be deemed to have been met.

G. Performance Standards and Exclusive Remedy

1. In the event that the MBBR system does not achieve the required level of performance during the test period, the MANUFACTURER shall be permitted to conduct up to one (1) additional test to meet the specified process guarantee criteria. Each testing period not to exceed 100 days. For any retesting, the OWNER shall bear the same responsibilities for labor and laboratory testing as indicated herein for the initial performance testing, and the OWNER shall continue to bear the same operational responsibilities as indicated for the initial test.

2. If the biological treatment system fails to achieve the required effluent quality during the performance test period and fails the additional test, the MANUFACTURER shall pay for labor and material associated with identifying the cause of the performance test failure as well as modifications to improve effluent quality, at no additional expense to the OWNER.

3. The total amount of all necessary modifications and retesting expended by the MANUFACTURER to satisfy any of the guarantees shall not exceed 1.0 times the amount paid for the MANUFACTURER's scope.

H. The MANUFACTURER shall provide Performance and Payment Bonds in an amount equal to 100 percent of the MANUFACTURER's contract amount. The Performance and Payment Bonds will be provided after the execution of MANUFACTURER's contract and will be released in writing upon successful completion of the performance test as set forth herein, however the bonds shall not be outstanding for longer than 18 months from the date the contract is executed. MANUFACTURER shall provide a letter from its surety company with its bid confirming the SYSTEM SUPPLIER's ability to provide such bonds. MANUFACTURER's bid will be rejected if it does not include a letter of surety.

3.07 MEASUREMENT AND PAYMENT

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

END OF SECTION

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PART I – GENERAL

1.01 SUMMARY

A. Furnish and install submersible, non-clog raw sewage pump(s) as specified herein and as shown on plans.

1.02 RELATED REQUIREMENTS

A. 01730 Operation and Maintenance Data
B. 17100 Process Instrumentation and Control System
C. 17900 Plant Control Philosophy

1.03 REFERENCES

A. TCEQ 30TAC Chapter 317

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

1.04 DEFINITIONS (NOT USED)

1.05 SYSTEM DESCRIPTION (NOT USED)

1.06 SUBMITTALS

A. Submittals

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

1. Pumps

a. Name of pumping unit Manufacturer.
b. Pump model number.
c. Rotating speed.
d. Proposed impeller size.
e. Maximum impeller size to fit proposed pump case.
f. Minimum impeller size to fit proposed pump case.
g. Performance curves for like unit showing total dynamic head, capacity, and horsepower from shutoff to beyond the minimum operating head at operating speed.
h. List of materials used in the construction of the pumps. Designate materials using ASTM Standards.
i. Type of wear rings and materials for impeller and case wear rings.
j. Type of pump bearings (radial and axial).

k. Type of mechanical seal and materials of construction.
l. Outline drawing of pumps showing exterior dimensions of pump.
m. Net weight of pump.
n. Net weight of base plate.

2. Motor

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

1.07 QUALITY ASSURANCE

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

B. Motor Compatibility

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

C. Efficiency and Cost Effectiveness

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

1.08 DELIVERY STORAGE AND HANDLING (NOT USED)

1.09 PRODUCT/SITE CONDITIONS (NOT USED)

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

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

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

1.10 WARRANTY

Warranty shall begin upon **substantial completion** of the lift station, following successful completion of the field testing and acceptance of the pump/motor assemblies.

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

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

C. The manufacturer shall also provide a full parts and labor warranty for the motor, its components, and its accessories for one year.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data .

PART II – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Flygt

B. KSB

C. Flowserve

2.02 MATERIALS/CONSTRUCTION

A. Pump

1. Volute

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

2. Shaft

   a. The pump shaft shall be constructed of solid stainless steel.

3. Bearings

   a. The solid pump and motor shaft shall be rigid and kept in correct alignment by bearings. The pump shaft shall rotate on two bearings. The upper bearing shall be a single deep grove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Bearings shall be anti-friction having a minimum B10 bearing life of 150,000 hours and designed to withstand all stresses to ensure a long service life. Bearing houses are to be designed so that water cannot enter housing. Bearings shall be permanently lubricated.

4. Impeller

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

5. Wear Rings

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

6. Mechanical Seals

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

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

7. External Hardware

    a. All external wetted hardware shall be 316 stainless steel.

8. O-Rings

    a. All O-rings shall be made of Buna N Rubber.

B. Motor

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

1. Construction

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

2. Motor Rating

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

3. Motor Housing

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

4. Rotor and Stator

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

5. Shaft

    a. The motor shaft shall be constructed of solid stainless steel.

6. Bearings

    a. See Pump section, above.

7. Insulation

        a. Motors shall be UL listed for Class H insulation operating temperature. The temperature rise criteria of 239°F over 104°F ambient shall be determined by resistance method or RTD's. Method of testing shall be listed in the motor submittal.

8. Motor Power/ Control Wiring and Cable

    a. Motor power lead wires shall be permanently and thermally connected to the stator for structural strength.

    b. Motor lead wires shall be connected to the power cable in a watertight chamber and appropriate watertight seal cable entrance. Pump motor power cable shall be oil and watertight, rated for continuous submerged service. Cable conductors shall be copper, sized and rated per N.E.C. Cable shall be sized using 125 % of motor nameplate.

    c. Motor control conductors for thermal and moisture leak sensory shall be rated for continuous submerged service and shall be run in a separate jacketed cable and conduit from the power cable.

    d. Power cable shall include a dedicated ground conductor. All conductors shall be permanently identified at both ends.

    e. Power/control cable shall be of sufficient length as designated with pump order to allow required power and control termination.

9. Motor Starting

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

10. Motor Over-temperature and Moisture Protection

    a. Motor shall have a stator winding over-temperature (OT) sensory or switch device to detect high temperature and provide shutdown protection. The OT device shall be rated and set to actuate providing protection and reaching the limits of the Class H insulation. OT sensory shall actuate in the vicinity of 77-86°F before the limits of Class H insulation rating and reset dead band of about 59-68°F. The pump/motor manufacturer shall furnish applicable OT sensory components and a complete schematic and wiring diagram.

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

C. Nameplate

1. Pump and Motor

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

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

2.03 FUNCTIONAL REQUIREMENTS

A. Operation

1. Pumps

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

2. Motor

   a. The manufacturer shall coordinate pump operation so that all physical and operational characteristics of the motor are compatible with the requirements of the pump.
   b. The motor shall operate efficiently, without overloading, overheating, or abnormal vibration, throughout the entire range of speed and load for the specified impeller.
   c. There shall be no point on the pump curves at which the motor name plate rating is overloaded, even momentarily.
   d. Motor shall be capable of bi-directional rotation by changing the electrical phase connections of the motor power lead wires.
   e. The motor shall be capable of up to 15 evenly spaced starts per hour.
   f. The motor shall be able to operate dry without damage while pumping under load.

B. Controls

1. See 17200 Process Instrumentation and Control System and 17900 Plant Control Philosophy.

C. Performance

1. Each pump supplied shall be tested for performance prior to shipment. Testing shall be in accordance with Hydraulic Institute and NEMA MG-1 Standards.

2. The pump shall operate at a minimum of 25% below its critical shaft speed.

3. Pump's capacity shall be given in gallons per minute and feet of water.

4. The lift station's firm capacity and the number of pumps operating to achieve that capacity shall also be provided.

5. Operating and design requirements shall be listed in the Supplemental Data Sheet provided in Section 3 of this document.

6. The motor shall have normal starting torque and low starting current per specified motor design per NEMA MG-1.

7. All motors, regardless of size, shall have a minimum 1.15 service factor for continuous duty.

2.04 TOOLS, SPARE PARTS, AND ACCESSORIES

A. Tools

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

B. Spare Parts & Spare Pump

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

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

    a. Spare Nameplates

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

C. Guide Rail System

1. Guide Rail

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

2. Guide Rail Brackets

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

E. Pump Lifting Chain

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

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

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

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

G. Pump Wire / Cable Support

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

I. Hardware

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

PART III – EXECUTION

3.01 GENERAL

A. Factory Inspection and Testing

1. Each pump is to be tested at the factory to determine capacity, shut-off head, rated head, minimum head (for continuous operation), required power, efficiency and as required to develop an accurate performance curve. Certified copies of a report for each test are to be submitted to the Owner. All of the above tests are to be performed in conformity with the requirements and recommendations of the Hydraulic Institute and NEMA MG-1. Refer to Specification Section 11000 - Pumps General for additional details. Refer to section 3.10 in this Specification for head and flow design points.

3.02 PREPARATION (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Field Installation

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

2. Installation shall be in accordance with Section 11100 – Pumps General.

3.04 REPAIR/RESTORATION

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

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

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

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

3.05 ADJUSTING

A. All adjustments required to ensure satisfactory operation of the equipment or to correct such minor errors or inaccuracies in the various parts as expected to occur during manufacturing shall be made by the Contractor with the approval of the manufacturer.

3.07 CLEANING

A. After installation of all equipment, the Contractor shall clean and check lubrication of all parts in preparation for testing and field painting. All lubricants shall be drained and replaced by the Contractor prior to final acceptance. Cost of lubricants shall be paid for by the Contractor. The grades of lubricants shall be in accordance with the manufacturer's printed instructions.

3.08 TESTING AND INSPECTION

A. The Contractor and the manufacturer shall conduct field tests with the equipment manufacturer’s representative in the presence of the Owner on all pumps and motors in accordance with Section 11100 – Pumps General. The pumps shall be tested in accordance with the latest edition of the Hydraulic Institute Standards.

B. Services of Manufacturer

a. Services of Manufacturer shall be in accordance with Section 11100 – Pumps General.

b. An authorized representative of the manufacturer shall visit the Site and perform the following:

i. Minimum of one (1) (8-hour day) with one (1) trip for on-site inspection, certification of installation, pump equipment software integration guidance onto SCADA system and configuration of pump protection unit.

ii. Authorized representative shall submit summary report on site to Contractor. Contractor shall forward reports to Owner.

3.09 STORAGE, HANDLING AND PROTECTION

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

3.10 SCHEDULES

Duty	Continuous
Ambient environment	Outdoors
Fluid service	Dewatering Filtrate
Pump Operation	Constant Speed
Equipment Number	LSPUMP-01, LSPUMP-02, LSPUMP-03
Quantity	2 Duty + 1 Standby
Location	BFP Effluent Lift Station

1. Performance Requirements

Design flow capacity per pump, gpm	450
Design flow pump head per pump, TDH ft	
Flow to EQ Basin (Normal Operation)	38.5
Flow to ATR Influent Splitter box (Alternative Operation - EQ Bypass)	40.7
Flow to Pond 1W (Alternative Operation - ARF Bypass)	44.7
Flow to SSTP (Alternative Operation)	53.2
Maximum motor size, hp	7.5

2. Pump Dimensions

Inlet Diameter, in	6

Discharge Diameter, in	6
Discharge flange rating, ANSI, psi	150

3.11 TRAINING

A. Qualified training representatives, approved in writing by the Owner, shall visit the site to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

B. Training shall be scheduled three weeks in advance of the scheduled session, at a date mutually agreeable by the Owner, manufacturer, and Sub-suppliers.

C. Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the Owner shall be incorporated into the material prior to the training sessions.

D. The training materials shall remain with the trainees after the session.

E. Owner's personnel shall be trained in the operation and maintenance of the pumps. Minimum of one (1) (8-hour day) with two (2) trips shall be furnished.

3.12 MEASUREMENT AND PAYMENT (NOT USED)

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes: Rotary-lobe blowers for air supply to the Ammonia Treatment Reactors (ATRs).

B. As specified in Section 11000 - Equipment General.

C. Tag numbers:

1. Rotary-lobe Blower No. 1: BLOWER-01.

2. Rotary-lobe Blower No. 2: BLOWER-02.

3. Rotary-lobe Blower No. 3: BLOWER-03.

1.02 RELATED REQUIREMENTS

A. PLANS show general arrangement and dimensions based on the AERZEN GM100S rotary lobe blower package. Selection of a different manufacturer may require a revised layout. Contractor shall coordinate with blower supplier.

1.03 REFERENCES

A. American Bearing Manufacturers Association (ABMA):

1. 9 Load Ratings and Fatigue Life for Ball Bearings.

2. 11 Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. 52.1 Testing for HVAC Air Filtration.

C. American Society of Mechanical Engineers (ASME):

1. B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

D. National Electrical Manufacturers Association (NEMA):

1. 250 Enclosures for Electrical Equipment (1,000 V Maximum).

1.04 DEFINITIONS

A. NEMA Type 4X enclosure in accordance with NEMA 250.

1.05 DESIGN AND PERFORMANCE CRITERIA

A. System components: ATR blowers and appurtenances.

B. General: ATR blowers and appurtenances shall include the following items and supplied by blower manufacturer:

1. Rotary positive displacement blower and motor.
2. Air intake filters.
3. Silencers, inlet, discharge, and vent.
4. Check valves.
5. Relief valves.
6. Flexible pipe connectors.
7. Suction/Discharge Pressure gauge/switch.
8. Acoustic enclosure.
9. Discharge temperature gauge/switch.
10. Appurtenances as required.

C. Design requirements:

	ATR Aeration Blowers
Type of Blower	Rotary lobe, positive displacement
Number of blowers	3
Design Flow Rate (per blower)	2,840 scfm
Design Inlet filter/Silencer pressure loss	0.3 pounds per square inch
Design discharge pressure	9.5 psig
Design inlet pressure[1]	14.4 psia
Summer Inlet temp. (F)	105
Winter Inlet temp. (F)	20
Site Elevation	438 ft MSL
Inlet relative humidity, average	85%
1) Ambient temperature may reach 112 deg. F. Blower unit shall be capable of operating at this temperature without problem.	

1. Motor: As specified in Section 16222 - Low Voltage Motors up to 500 Horsepower, except as otherwise specified or supplemented below:

Power supply	480-volt, 3-phase, 60-hertz
Horsepower	200 HP
Motor Speed	1,800 rpm
Enclosure	TEFC
Service factor	1.25

2. Drive: Belt.

3. Noise control:

    a. Sound pressure levels radiated from equipment furnished shall not exceed 80 dBA (mean, A-weighted) at 3 feet (RE 2 x 10-5 N/m2) for free field condition when unit is in operation at rated flow.

4. Vibration:

    a. Maximum acceptable peak vibration velocity (unfiltered) for blower equipment is 0.45 inches per second.

5. Provide control panel, instrumentation, and alarms as indicated on the P&ID Drawings and as specified in Division 17.

1.06 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data:

1. Blower information:

    a. Manufacturer.

    b. Model.

    c. Blower speed in revolutions per minute.

    d. Blower site capacity, actual cubic feet per minute.

    e. Discharge pressure, pounds per square inch absolute.

    f. Horsepower required including loss in V-belt drive.

    g. Weight of blower.

h. Weight of motor.

i. Free-field noise level at 3 feet from blower acoustic enclosure.

2. Motor performance and construction data.

3. Construction details of acoustic enclosure.

4. Descriptive brochures and applicable performance and construction data for each item of auxiliary equipment along with their weights.

5. Certified test data on equipment performance, vibration, and noise. Certification shall be by an authorized representative of the blower manufacturer.

C. Shop drawings:

1. Blower panel device layout and material list.

D. Calculations: As specified in Section 11000 – Equipment General.

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

F. Commissioning submittals:

1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01650 – Facility Startup/Commissioning.

2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in 01650 – Facility Startup/Commissioning.

1.07 QUALITY ASSURANCE

A. System Coordination:

1. CONTRACTOR retains overall responsibility to properly install, adjust, test, and place in operation the blower units.

2. All units for each service provided under this Specification shall be the products of a single manufacturer. All motors for each service provided under this specification shall be the product of a single manufacturer.

B. Manufacturer's Qualifications:

1. The Contractor shall provide evidence to the Engineer that the manufacturer has a minimum of five (5) years experience, within the last ten (10) years, in the design, manufacture, and supervision of installation of equipment of the type and size specified (or larger) under this Specification.

2. The Contractor shall provide evidence to the Engineer that equipment which was designed and manufactured by the manufacturer, and which is similar to the equipment required under this Specification, has been in continuous and successful operation in at least five (5) separate facilities for the past five (5) years.

1.08 WARRANTY

A. The equipment seller shall be solely and fully responsible for warranty and mechanical design adequacy of all the blower components in the scope of supply defined in this section of the specification. This warranty shall become effective for a period of one (1) year from the date of substantial completion.

1.09 DELIVERY, STORAGE AND HANDLING

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

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

PART II - PRODUCTS

2.01 MANUFACTURER(S)

A. One of the following or equal:

1. Aerzen, Model GM100S, or equal by:

2. Kaeser Compressors

2.02 MATERIALS

A. General:

1. ATR blower assembly: Complete with blower, drive, inlet and discharge silencers, valves, and appurtenances.

2. Blower rating: As specified above.

B. Blower and drive:

1. General:

a. Blower shall deliver oil-free air.

b. Blower and motor mounting: On common base.

c. Lifting provisions: Lifting eyes on blowers, motors, and base so each major component or entire unit can be lifted.

d. Piping connections: 125 pound class flanges in accordance with ASME B16.1.

2. Type: Positive displacement rotary blowers using 2 impellers to pressurize a trapped volume of air at a controlled rate prior to exposing it to a discharge pressure.

3. Casing and head plates:

a. Blower casing: 1 piece with separate head plates and end covers.

b. Casing and head plates: Made of close-grained, machined cast iron.

c. End covers and head plates: Reinforced with bosses at penetrations with cast, machined support feet.

4. Impellers:

a. Material: Ductile iron or cast iron.

b. Design: Straight, tri-lobe, involute type.

c. Balance: Statically and dynamically balanced per ISO 1940/ANSI S2.19 G6.3.

d. Operation: Free of rubbing without need for liquid seals or lubrication.

e. Timing: positively by a pair of accurately machined, heat-treated, alloy steel timing gears.

f. Shafts: Alloy steel forgings, pressed into each end of each impeller and pinned.

g. Impeller assembly support: Anti-friction type bearings, sized for a minimum ABMA 9 and 11 L10 life for bearings of 100,000 hours.

5. V-belt Drive:

a. Each package shall be supplied with a V-belt drive that shall be of the high capacity type, oil and heat resistant.

b. Belt tensioning shall be automatic without the use of any devices or interaction on the part of the operator. Neither slide rails nor load-adjusting springs shall be used.

c. Sheaves shall be dynamically balanced regardless of the operating speed.

d. The belt drive shall be guarded in compliance with OSHA regulations.

e. Portions of the guard shall be easily removable allowing for belt inspection and replacement.

6. Lubrication:

a. Positive oil seal: Provided at each bearing.

b. Seal design: Capable of preventing lubricant from leaking into air stream.

c. An oil level indicator must be provided and shall be visible on the outside of the blower enclosure.

d. Vent provisions: Capable of venting impeller side of oil seal to atmosphere while eliminating possible carryover of lubricant into air stream.

e. Drive-end bearings: Grease or oil lubricated.

f. Timing gears and gear-end bearings: Splash oil lubricated.

g. Blower's shipment: With openings sealed after injection of rust inhibitor.

2.03 APPURTENANCES

A. Inlet filter shall have front access for filter element access. The filter media efficiency must meet the requirements of ASHRAE 52.2 MERV7 50-70% @3-10 microns corresponding to EN779 G4.

B. Silencers:

1. Manufacturers: The following or equal:

a. Burgess-Manning, Model BMSI, BMSS.

b. Aerzen, equivalent product; or equal

2. Construction: Welded steel.

3. Discharge silencer: Chamber type design which shall use no fibrous or absorption material. Single shell of pressure vessel quality steel with continuous welds subject to a pressure test for tightness and strength at a minimum of 1.65 times the maximum blower operating pressure.

4. Silencers sizing: For design conditions and specifically designed for use with positive displacement blowers, size as indicated on the Drawings unless a larger size is recommended by the manufacturer.

5. Mounting of silencers: Inside the acoustic enclosure and per manufacturer.

C. Acoustic enclosure:

1. Galvanized sheet-metal sandwich construction.

2. With noise attenuating walls and with ventilation openings ported, ducted, shielded, and lined with acoustic absorptive material as required to achieve specified noise levels.

3. Suitable for outdoor unprotected installation.

4. With ventilation system designed for sufficient heat removal from the sound enclosure even when operating a VFD at all speeds. If a separate motor-driven ventilation fan is used, the fan motor shall be prewired into a separate junction box that is interlocked with blower motor to start when blower starts and which will not allow the main drive motor to start if the cooling fan motor doesn't start. Fan to stop with an adjustable time delay after the blower motor stops. Alternatively, a high efficiency blower shaft driven ventilation fan shall provide adequate cooling at all speeds.

5. With a weather-protected ventilation air intake filter (if separate ventilation air intake is required):

   a. Of disposable, dry type, pleated lofted cotton and polyester fiber media construction, securely bonded to a welded galvanized wire backing, with a frame of heavy-duty paperboard.

   b. Sized for not more than 400 feet per minute face velocity.

   c. With ASHRAE Standard 52.1 cleaning efficiency of not less than 25 percent.

   d. With thickness not less than 1 inches.

   e. With an easily visible and resettable "replace filter" indicator with retained indication independent of blower on/off status.

6. With removable access panels located for maintenance and inspection access to the housed equipment, each weighing not more than 40 pounds, or hinged if weight exceeds 40 pounds.

7. UL-94 fire rated sound absorption material.

D. Relief valve: High-capacity, full-nozzle type; 2 inch minimum valve inlet:

1. Manufacturers: The following, or equal:

   a. Kunkle Valve Co.

E. Butterfly valves:

1. Constructed as specified in Sections 15202 - Butterfly Valves.

2. Lined with 10 mils of epoxy suitable for temperatures to 350 degrees Fahrenheit.

3. Sealed with seals suitable for temperatures of 350 degrees Fahrenheit.

F. Check valves: No. 8808-GAX-SSF; dual disc, wafer style with torsion spring induced closure:

1. Manufacturers: The following, or equal:

a. Val-Matic.

2. Consisting of following components:

a. Valve body: ASTM A126 cast iron.

b. Disc: ASTM B148-9A, aluminum bronze.

c. Spring: ASTM A276, Type 316 stainless steel.

d. Pins and thrust bearings: ASTM A276 Type 316, stainless steel.

e. Seals, rated for minimum 350 degrees Fahrenheit.

G. Pressure gauges: Liquid filled case with minimum 4 inch dial face:

1. On suction and discharge sides of blower.

2. Suction side vacuum gauge calibrated in inches of water, -40 to 0 inches scale. Discharge side pressure gauge calibrated in pounds per square inch gauge, 0 to 15 psi scale. Mounted to front of enclosure.

3. A suitable tee handled corporation stop or ball valve and snubber shall be installed between each gauge and connection to air piping.

H. Discharge temperature gauge/switch:

1. Switch shall contain NEMA 4 enclosure. Temperature set point as recommended by manufacturer.

2. Temperature gauge shall be liquid filled case with minimum 4 inch dial face calibrated in degrees Fahrenheit with scale from 32 deg F to 400 deg F. Mounted to front of enclosure.

3. A suitable tee handled corporation stop or ball valve and snubber shall be installed between each gauge and connection to air piping.

I. Pressure Switches:

1. Discharge High Pressure Switch

a. Diaphragm or diaphragm-sealed piston type .

b. Set point as recommended by blower manufacturer.

c. Manufacturer shall be one of the following, or equal:

1) ASCO, S-Series.

2) Ashcroft, B Series.

3) United Electric, Control Series.

d. Provide operator adjustable alarm and shutdown set points with initial settings recommended by manufacturer.

2. Suction Low Pressure Switch:

a. Diaphragm or diaphragm-sealed piston type.

b. Set point as recommended by blower manufacturer.

c. Manufacturer shall be one of the following, or equal:

1) ASCO, S-Series.

2) Ashcroft, B Series.

3) United Electric, Control Series.

d. Provide operator adjustable alarm and shutdown setpoints with initial settings recommended by manufacturer.

J. Other safety devices and controls: As recommended by blower manufacturer.

K. Rubber expansion joints:

1. Provided at inlet and discharge flanges of blowers.

2. Suitable for pressures up to 15 pounds per square inch gauge and temperature up to 350 degrees Fahrenheit.

3. At discharge joints, provided with control rods to restrict axial pipe movement.

4. Manufacturers: The following or equal:

a. General Rubber.

b. Proco.

5. Expansion joints outside acoustic enclosure shall be supplied by contractor.

L. Supports and bracing: As required to support blower, associated equipment and piping, and to prevent excessive or harmful vibration or movement of equipment or piping.

2.04 CONTROLS

A. Refer to Drawing 05-I-601 for the process and instrumentation drawing for the blower system.

B. Field Control Station to be provided by others. Refer to electrical drawings.

2.05 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: Provide the following:

1. 3 complete sets of ventilation and air intake filters.

2. 3 lubrication oil filter cartridges, if oil filters are required.

3. 3 sets of drive belts:

a. Label spare parts as specified in Section 01600 – Materials and Equipment and box for storage.

B. Special tools: Provide the following:

1. 1 set of special tools with equipment when required for normal operation and maintenance.

PART III - EXECUTION

3.01 INSTALLATION

A. Install adequate supports and bracing to support blower, associated equipment and piping, and to prevent excessive or harmful vibration or movement of equipment or piping resulting from operation of the system.

3.02 COMMISSIONING

A. As specified in Section 01650 – Facility Startup/Commissioning, 11000 – Equipment General, and this Section.

B. Manufacturer services:

1. Provide certificates:

a. Manufacturer’s Certificate of Source Testing.

b. Manufacturer’s Certificate of Installation and Functionality Compliance.

2. Manufacturer's Representative onsite requirements:

    a. Installation inspection: 1 trip, 2-day minimum.

    b. Functional Testing: 2 trips, 1-day minimum each.

3. Training:

    a. A minimum of two separate days of training shall be provided. Trainers shall be available for 8 hours each day.

    b. Because of staff shift schedule, the trainer shall expect to present information more than once per day.

    c. The training shall include operational training and maintenance training. The split in training material for the day shall be coordinated by Contractor with input by plant staff before the visit.

C. Source testing:

1. Blowers shall be tested to certify the performance requirements specified in Paragraph 1.05.C. Testing shall be made available for witnessing by Owner and/or Engineer.

2. Blower manufacturer shall follow the International Organization for Standardization test ISO-1217, Annex C Acceptance Test, to confirm power input at specified design requirements.

D. Field testing:

1. Electrical and Controls:

    a. Refer to Section 17100 for requirements on Operational Readiness Test (ORT) and Performance Acceptance Test (PAT).

2. Rotary Lobe Blower System:

    a. Perform Functional Test for 8 hours as specified in Section 01650-3.03.

        1) Functional test shall include the operation of each blower over its entire speed range.

        2) Obtain concurrent readings of motor voltage, amperage and discharge pressure for at least 4 separate speed conditions including design max speed. Minimum test speed shall be no greater than 40% of max speed.

        3) Bearing temperature shall be measured by contact -type thermometer. Test shall be preceded with a run time sufficient to stabilize bearing temperatures.

b. Operational Performance Testing

1) The operational performance test for the blowers shall commence in conjunction with the performance test of the deammonification system. The blowers shall operate without issue for 7 full days for the performance test to be considered complete.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Laboratory work surfaces, including:

B. Molded epoxy.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.

1.03 REFERENCES

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

1. American Plywood Association (APA).

2. Architectural Woodwork Institute (AWI).

3. ASTM International (ASTM):

a. D 570 - Standard Test Method for Water Absorption of Plastics.

b. D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.

c. D 785 - Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.

d. D 790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

4. National Electrical Manufacturer's Association (NEMA):

a. LD 3 - High Pressure Decorative Laminates (HPDL).

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Product data.

B. Shop drawings:

1. Include dimensions, features of construction, performance characteristics, materials, and installation instructions.

2. Show materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory lists, hardware, hardware location, and schedule of finishes.

1.07 QUALITY ASSURANCE

A. Manufacturer qualifications: Completion of minimum 10 comparable installations within last 5 years.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Wrap and crate finished components and assemblies at factory to prevent damage or marring of assemblies or surfaces during shipping and handling.

B. Deliver materials to site, unload, and store in designated locations.

1. Coordinate size of access and route to place of installation.

1.09 PROJECT CONDITIONS

A. Field measurements: Verify field measurements prior to preparing shop drawings.

B. Move in equipment when finishes are completed.

C. Maintain room temperature of at least 65 degrees Fahrenheit for 72 hours before

equipment installation begins, and continuously after installation.

PART 2 - PRODUCTS

2.01 MOLDED EPOXY WORK SURFACE AND SINKS

A. Manufacturer: One of the following or equal:

1. Kewaunee Scientific Equipment Corporation, Stateville, NC.

B. Material: Kewaunee "Kemresin," especially compounded, uniformly mixed and cured modified epoxy resin with following physical properties:

1. Flexural strength: 15,000 pounds per square inch when tested in accordance with ASTM D 790.

2. Compressive strength: 35,000 pounds per square inch when tested in accordance with ASTM D 695.

3. Hardness, Rockwell M: 100 when tested in accordance with ASTM D 785.

4. Water absorption, percent by weight:

a. 24 hours: 0.02 when tested in accordance with ASTM D 570.

b. 7 days: 0.04 when tested in accordance with ASTM D 570.

c. 2-hour boil: 0.04 when tested in accordance with ASTM D 570.

5. Specific gravity: 1.97.

6. Tensile strength: 8,500 pounds per square inch.

C. Fabrication: Mold laboratory work tops to the following sizes and configuration:

1. 1-inch thick top with exposed edges rounded with 1/4-inch radius, drip grooves on underside of exposed edges.

2. Curbs/backsplashes: 3/4-inch thick integral 4-inch high curbs with coved juncture between tops and curbs at 3/4-inch radius for standard 24- and 31-inch wide tops.

3. Under counter type sink cutouts: Without saw marks, top edge rounded to 1/8- inch radius and corners rounded to 3/4-inch radius with underside of opening finished smooth to eliminate sharp edges.

4. Fabricate tops in largest practical sections, minimizing number of joints.

D. Sinks:

1. Handwash Sink:

a. Sinks shall be of the undercounter type and shall have coved inside corners and the bottom pitched to the drain outlet.

b. Sinks shall be provided with lead stoppers and overflow stoppers. Sink size shall be 16 inch square and 8 inches deep, and as indicated on the Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before installation, check building dimensions and rough-in of services.

3.02 INSTALLATION

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

B. Insulate areas between dissimilar metals to prevent electrolysis.

C. Sequence installation and erection to ensure mechanical and electrical connections are effected in an orderly and expeditious manner.

D. Cut, fit, and patch work as necessary, coordinating work fully.

E. Monitor connection of services as specified in Sections 15050 and 16050.

F. Fill joints between molded epoxy countertop sections and between sink and countertop, with acid, alkali, and solvent-resistant material compatible with top to form a smooth integral surface.

1. Sink installation shall be watertight.

G. Tolerances:

1. Flatness shall be 1/16-inch for each 48-inch span.

2. Location of cutouts and drillings shall be within 1/16 inch. Size of cutouts and drillings shall be within 1/16 inch.

3.03 ADJUSTING AN CLEANING

A. Test, clean, and adjust equipment and apparatus to ensure proper working order and conditions.

B. Do not sand or excessively fill tops to meet tolerances.

END OF SECTION 12346

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Metal Laboratory furniture including all components of laboratory cabinets; base, sink, wall and floor cabinets with doors, drawers, reagent and utility shelves, and all related accessories.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.

1.03 (NOT USED)

1.04 (NOT USED)

1.05 (NOT USED)

1.06 SUBMITTALS

A. Product Data: Include dimensions, features of construction, performance characteristics, and materials.

B. Shop Drawings: Include floor plans and elevations of assembled casework. Indicate cabinet work in full detail. Show materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory listings, hardware, hardware location, and schedule of finishes.

C. Sample: Full size sample of proposed cabinetwork. Accepted sample will be standard against which work will be evaluated. Accepted sample may be part of Work.

D. Manufacturer's Installation Instructions.

E. SUSTAINABLE DESIGN SUBMITTALS

1. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design submittals.

2. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

    a. Materials Resources Certificates:

        1) Certify recycled material content for recycled content products.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer Qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Wrap and crate finished components and assemblies to prevent damage or marring of assemblies or surfaces during shipping and handling. Do not remove protective coverings until time of installation.

B. Deliver materials to site, unload and store in designated locations. Store products indoors, in a dry location, out of the way of construction activities. Coordinate size of access and route to place of installation.

1.09 PROJECT CONDITIONS

A. Move in equipment when finishes are completed.

B. Maintain room temperature of at least 65 degrees Fahrenheit for 72 hours before equipment installation begins, and continuously after installation.

C. Field Measurements: Verify field measurements prior to preparing shop drawings.

1.10 (NOT USED)

1.11 (NOT USED)

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Laboratory Casework: One of the following or equal:

1. Kewaunee Scientific Equipment Corp., Statesville, NC.

2. Hamilton Manufacturing Co.

3. St. Charles Manufacturing Co.

2.02 WALL AND BASE CABINETS

A. General: (Numbers indicated on the Drawings reference products by Kewaunee Scientific Equipment.)

B. Sectional Units:

1. Each sectional unit shall have flush face construction and shall be completely fabricated ready for placement in the laboratory furniture and equipment assembly and shall be a complete integral rigid unit in itself to permit relocation at any subsequent time. Construction and design shall develop maximum strength and rigidity in each sectional unit.

2. All component parts of the sectional unit shall be die formed insuring uniformity and interchangeability and shall be assembled in jigs for accurate alignment.

3. All joints shall be notched, keyed and overlapped forming interlocking joint construction. Vertical and horizontal members shall be spot-welded and shall be both spot-welded and arc welded at all stress points. Screws shall not be used in the construction of the unit proper and shall only be used where backs, pans and panels are required to be removable for accessibility.

4. All sectional units to be located on the laboratory floor shall be equipped with leveling devices easily adjustable from within the units, to compensate for unevenness in the laboratory floor.

5. Black rubber base molding shall be furnished. Base molding shall be applied to the units after the units have been securely bolted together in the assembly in the laboratory.

6. Each unit shall consist of drawers or cupboard or a combination thereof as indicated and shall harmoniously fit into the laboratory assembly.

7. All units, unless otherwise specified, shall have backs with removable panels for access to the pipe spaces at the rear of the units. Removable panels shall be provided in sides of units where units occur in the corners of the rooms and access is required to the pipe spaces. These removable panels shall be designed to permit removal through the fronts of the units.

8. All units shall have a cleanable smooth interior. Front and rear posts, reinforcing members or channel uprights shall be enclosed full height on all cupboard openings.

9. Drawer Heads: Sectional unit drawer heads shall be of double wall sound deadened construction and shall have sound deadening mineral type filler or wood battens between the inner and outer pans for quiet operation.

10. Drawer Slides: Each drawer shall operate on four nylon rollers. Drawers shall close flush with the unit rails and against rubber bumpers. Self-closing drawer slides shall be provided on all drawers to prevent rebounding when drawers are closed. Drawers shall be removable without the use of tools and shall be provided with stops to prevent inadvertent removal.

11. Doors: Sectional unit doors shall be of double wall sound deadened construction and shall have sound deadening mineral type filler or wood battens between the inner and outer pans. Reinforcements and hinge mounting brackets shall be concealed between the outer pans and inner pans. Doors shall be hung with a pair of institutional type hinges. Hinge leaves shall be concealed. The inner and outer pans of doors shall be flanged all around and shall fit with minimum clearance. Door openings in units shall be fully rabbetted and doors shall close flush with the unit rails and against rubber bumpers.

12. Corner gusset plates shall be provided in each corner of the sectional units and shall have double offset attachment flanges for welding to the unit proper. Each gusset plate shall be provided with a leveling device. The leveling sockets shall be integral parts of the gusset plates. Each 1/2-inch leveling bolt shall be slotted for easy adjustment with a screwdriver from above. Access to the leveling bolts shall be through holes in the cupboard bottoms directly above the leveling bolts. These access holes in the cupboard bottoms shall be provided with removable snap-on covers. Corner gusset plates shall be 14 gauge.

13. Sliding Doors: Where sliding doors are specified or indicated, these doors shall be of double wall construction, glazed where specified, and operate on nylon rollers running on aluminum tracks.

14. Hardware and Trim: All units shall be complete with all hardware and trim such as drawer and door pulls, flush pulls, hinges, locks (where shown), catches adjustable shelf clips, leg shoes, and base molding. Door and drawer pulls shall be of aluminum with a brushed satin finish.

C. Base Cabinets with Sinks: Sink sizes shall be as indicated on the Drawings. Sink hangers, tail pieces and traps shall be supplied with all sinks.

D. Spacers, Aprons, Legs, and End Panels: Spacers, aprons, legs, and end panels shall be furnished where required whether individually indicated on the Drawings or not, to provide a complete, well-supported, finished installation.

E. Wall Mounted Cabinets: All wall cabinets shall be mounted on blocks which have been bolted to the wall with not less than four 3/8-inch bolts for each cabinet. Each unit shall be wall mounted on 1 by 4 hardwood cleats or in accordance with the manufacturer's standard methods for installing these cases.

F. Full Height Floor Storage Cabinets: Sliding door storage cases shall have a completely finished interior same as exterior. Doors shall be suspended from the top by nylon rollers in an extruded aluminum track. Track shall be so designed to prevent accidental removal of doors in operating position.

2.03 HARDWARE AND TRIM

A. Drawer and Door Pulls: Drawer and door pulls shall be modern design, offering a comfortable hand grip, and be securely fastened to doors and drawers.

1. Material and Finish: Aluminum, satin finish, with a clear, lacquer finish. Use of plastic pulls will be not be acceptable.

2. Provide 2 pulls on all drawers over 24 inches long.

B. Flush Pulls: Flush pulls for sliding doors shall be satin finish chrome, providing a recessed finger grip. Finger holes or slots machined into doors will be not be acceptable.

C. Hinges:

1. Hinges - 0.095 steel, butt-type, wrap-around, tight pin, hospital tip, five leaf, 2-3/4 inch heavy duty, institutional grade, with brushed chrome finish:

a. Doors over 48 inches high shall have 3 hinges per door.

b. Hinges shall be the five knuckle institutional, offset type for all swinging doors.

c. Hinges shall be 2-1/2 inches long, one pair for doors under 4 feet in height and 1-1/2 pair on doors over 4 feet in height.

d. Hinges shall be mounted with flathead screws, so applied to door and cabinet to withstand a weight load of 150 pounds minimum.

e. All hinges shall be satin finish stainless steel.

D. Locks:

1. Locks shall be applied to all doors and drawers as indicated on the Drawings or called for in the equipment list. Exposed surface of locks shall match other cabinet trim.

2. Keying: All locks, for the purpose of coordinating keying systems, shall be Illinois or National offering positive tumbler operation accomplished by cam action without the aid of springs.

E. Magnetic Latches: Provide on all swinging doors:

1. Latches shall be enclosed in a plastic case and operate against a strike plate on door.

2. Double doors (without locks) shall have a latch on each door.

3. Full height cases shall have latching devices located on the structurally fixed center shelf. Left hand doors on full height cases shall have a positive catch and right hand door shall have the magnetic type latch.

F. Elbow Catches: Elbow catches and strike plates shall be used on left hand doors of double door cases where locks are used, and shall be steel, cadmium plated.

G. Drawer Stops and Slides:

1. Drawer stops shall be provided on the inside back of each drawer, so designed as to prevent the accidental removal of the drawer. Drawer stop shall be steel, cadmium or chrome plated.

2. Drawer slides shall be self-closing side mounted steel slides, wrapped under drawer body sides to provide structural support with 4-point suspension nylon rollers and positive top, 100-pound rating. File drawers shall have full extension slides.

3. All units shall be complete with all hardware and trim such as drawer and door pulls, flush pulls, hinges, locks (where shown), catches, adjustable shelf clips, leg shoes, and base molding.

H. Leg Shoes: Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Shoes shall be 2-1/2 inches high and a pliable, black vinyl material.

I. Support Rods, Upright Rod Assemblies, and Rod Sockets: Upright rods, cross rods and ring support rods, where specified, shall be anodized Duralmin (1/2 inch or 3/4 inch diameter, as required). Rod sockets shall be chrome-plated brass, secured through tabletops with lock nut and spring washer. Rod clamps shall be heavy duty, designed to securely hold rod assembly in any position. Use of wood rod assemblies will not be acceptable.

J. Label Holders: Label holders, when specified, shall be self-adhesive type aluminum with satin finish and designed for 2-1/2 inch by 1-1/8 inch cards, unless otherwise indicated.

K. Support Struts: Support struts shall consist of two 16 gauge channel uprights fastened top and bottom by 2 adjustable "U" shaped spreaders, each 1/8-inch by 1-1/2 inch by length required. Struts shall be furnished to support drain troughs and fume hood superstructures, or other abnormal loads. Struts shall be furnished with hangers to support mechanical service piping and drain lines. Support struts shall be finished with black acid resistant enamel:

1. Floor Glides: Floor glides for movable open-leg tables, shall be a nonmarring material at least 1-1/2 inch diameter to prevent indenting composition flooring and shall have at least a 5/8-inch height adjustment. Use of metal buttons will not be acceptable.

2. Shelf Support Clips: Shelf support clips shall be pin type for mounting on interior of cabinet work. Coated finish, shall prevent corrosion, and retain shelves from accidental removal. Shelves shall be adjustable on centers not to exceed 2 inches. Surface mounted metal support strips and clips subject to corrosion are not acceptable.

2.04 BALANCE TABLES

A. Balance tables shall be natural quarried stone, marble, or cast epoxy resin tables. Legs shall be reinforced with a cast iron support pipe. All edges shall be rounded. Marble top and legs shall be 3 inches thick and accurately cut to provide a smooth level working surface.

2.05 GLASSWARE PEGBOARDS

A. Provide glassware pegboards at the locations indicated on the Drawings.

B. Board shall be constructed of a synthetic stone material fabricated of Portland cement and asbestos fibers impregnated with phenolic resin and surfaced with multiple coats of an acid resistant coating baked on at a high temperature.

C. Pegs shall be white polypropylene with rounded top and shall be designed for easy removal and replacement. Pegs shall enter the board at an angle to prevent rotation.

D. Pegboards shall have stainless steel drip troughs fastened to bottom.

2.06 FABRICATION

A. All methods used in fabrication shall conform to the best practices of the Scientific Laboratory Equipment Industry, including any specialized materials required.

2.07 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 - Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content.

C.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before installation, check building dimensions, and rough in of services. Starting work means acceptance of other in-place work.

3.02 INSTALLATION

A. Install products in accordance with the manufacturer's instructions.

B. Install furniture complete and ready to operate. Include all filler, scribe and end panels.

C. Install cabinets true and level.

D. Adjust and lock leveling adjusters.

E. Insulate areas between dissimilar metals to prevent electrolysis.

F. Sequence installation and erection to ensure mechanical and electrical connections are effected in an orderly and expeditious manner.

G. Cut, fit, and patch work as necessary, coordinating work fully with other trades involved. Install reinforcement in walls as required.

H. Monitor connection of services mechanical and electrical services in accordance with Sections 15500 and 16200.

I. Install cove base once cabinets are in their final position.

3.03 ADJUSTING AND CLEANING

A. Test, clean, and adjust equipment and apparatus to ensure proper working order and conditions.

B. Clean all cabinets and countertops with soap and water. Rinse with clean water only. No solvent or oil based cleaners, polishes, waxes, or similar products shall be used.

END OF SECTION 12355

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PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Blower Building requirements for:

1. Manually operated sunscreen roller shades

2. Manually operated room-darkening shades

1.02 RELATED REQUIEMENTS

A. Section 06110 – Rough Carpentry: Concealed blocking for attachment of work of this section.

B. Section 08110 – Steel Doors and Frames: Silencers integral with steel frames.

C. Section 08410 – Metal Framed Storefronts.

D. Section 08260 – Gypsum Board Assemblies.

1.03 REFERENCES

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

B. ASTM

1. G 21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to FungI.

C. NFPA

1. 701-99 – Fire Tests for Flame-Resistant Textiles and Films.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.

2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.

3. Storage and handling requirements and recommendations.

4. Mounting details and installation methods.

B. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, and relationship to adjacent work.

C. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.

D. Samples:

1. Selection Samples: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.

2. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements. Shadecloth sample and aluminum finish sample as selected. Mark face of material to indicate interior faces.

E. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

F. Warranty.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of ten years' experience in manufacturing products comparable to those specified in this section.

B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of 3 years' experience in installing products comparable to those specified in this section.

C. Fire-Test-Response Characteristics: Passes NFPA 701-99 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

D. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

E. Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

F. Environmental Certification: Submit written certification from the manufacturer, including third party evaluation, recycling characteristics, and perpetual use certification as specified below. Initial submittals, which do not include the Environmental Certification, below will be rejected. Materials that are simply 'PVC free' without identifying their inputs shall not qualify as meeting the intent of this specification and shall be rejected.

G. Third Party Evaluation: Provide documentation stating the shade cloth has undergone third party evaluation for all chemical inputs, down to a scale of 100 parts per million, that have been evaluated for human and environmental safety. Identify any and all inputs, which are known to be carcinogenic, mutagenic, teratogenic, reproductively toxic, or endocrine disrupting. Also identify items that are toxic to aquatic systems, contain heavy metals, or organohalogens. The material shall contain no inputs that are known problems to human or environmental health per the above major criteria, except for an input that is required to meet local fire codes.

H. Recycling Characteristics: Provide documentation that the shade cloth can and is part of a closed loop of perpetual use and not be required to be down cycled, incinerated or otherwise thrown away. Scrap material can be sent back to the mill for reprocessing and recycling into the same quality yarn and woven into new material, without down cycling. Certify that this process is currently underway and will be utilized for this project.

I. Perpetual Use Certification: Certify that at the end of the useful life of the shade cloth, that the material can be sent back to the manufacturer for recapture as part of a closed loop of perpetual use and that the material can

and will be reconstituted into new yarn, for weaving into new shade cloth. Provide information on each shade band indicating that the shade band can be sent back to the manufacturer for this purpose.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.10 WARRANTY

A. Roller Shade Hardware, Chain and Shadecloth: Manufacturer's standard non-depreciating twenty-five year limited warranty.

B. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas.

1.11 NOT USED

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Roller Shade Manufacturers: One of the following or approved equal:

1. MechoShade Systems, Inc. Long Island City, NY.

2. BTX Window Automation, Inc., Dallas, TX.

3. Draper, Inc., Spiceland, IN.

2.02 MATERIALS

A. Roller Shade Schedule: Basis of Design: MechoShade Systems.

1. Shade Type 1: Manual operating, chain drive, sunscreen roller shades in all exterior windows of rooms and spaces shown on the Drawings.

B. Components:

1. Shade Cloth:

a. Visually Transparent Single-Fabric Shadecloth: MechoShade Systems, Inc., ThermoVeil group, single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 21 percent polyester and 79 percent reinforced vinyl, in colors selected from manufacturer's available range.

1) Open Linear Weave: "1800 series", 15 percent open, linear-weave pattern.

2) Color: Selected from manufacturer's standard colors.

3) Other Manufacturers equivalent products.

C. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.

1. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.

2. Shade band and Shade Roller Attachment:

a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch (39.37 mm) in diameter for manual shades, and less than 2.55 inches (64.77 mm) for motorize shades are not acceptable.

b. Provide for positive mechanical engagement with drive / brake mechanism.

c. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" snap-off" spline mounting, without having to remove shade roller from shade brackets.

d. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.

e. Any method of attaching shade band to roller tube that requires the use of: adhesive, adhesive tapes, staples, and/or rivets are not acceptable.

D. Shade Fabrication:

1. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.

2. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3.18 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design. Fabricate hem as follows:

a. Concealed hemtube.

3. Rubber bumpers.

E. Provide battens in standard shades as required to assure proper tracking and uniform rolling of the shadebands. Contractor shall be responsible for assuring the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, shall be responsible for establishing appropriate standards to assure proper tracking and rolling of the shadecloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.

F. For railroaded shadebands, provide seams in railroaded multi-width shadebands as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shadebands.

G. Provide battens for railroaded shades when width-to-height (W:H) ratios meet or exceed manufacturer's standards. In absence of manufacturer's standards, be responsible for proper use and placement of battens to assure proper tracking and roll of shadebands.

2.03 COMPONENTS

A. Access and Material Requirements:

1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.

2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.

3. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and /or polyester, or reinforced polyester will not be acceptable.

B. Manual Operated Chain Drive Hardware and Brackets:

1. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.

2. Provide hardware capable for installation of a removable fascia, for both regular and/or reverse roll, which shall be installed without exposed fastening devices of any kind.

3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.

4. Provide shade hardware system that allows for operation of multiple shade bands (multi-banded shades) by a single chain operator, subject to manufacturer’s design criteria. Connectors shall be offset to assure alignment from the first to the last shade band.

5. Provide shade hardware system that allows multi-banded manually operated shades to be capable of smooth operation when the axis is offset a maximum of 6 degrees on each side of the plane perpendicular to the radial line of the curve, for a 12 degrees total offset.

6. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable.

7. Provide shade hardware constructed of minimum 1/8-inch (3.18 mm) thick plated steel or heavier as required to support 150 percent of the full weight of each shade.

8. Drive Bracket / Brake Assembly:

a. MechoShade Drive Bracket model M5 shall be fully integrated with all MechoShade accessories, including, but not limited to: SnapLoc fascia, room darkening side / sill channels, center supports and connectors for multi-banded shades.

b. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inch (9.525 mm) steel pin.

c. The brake shall be an over -running clutch design which disengages to 90 percent during the raising and lowering of a shade. The brake shall withstand a pull force of 50 lbs. (22 kg) in the stopped position.

d. The braking mechanism shall be applied to an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes an articulated brake assembly, which assures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated. Products that require externally applied lubrication and or not permanently lubricated are not acceptable.

e. The entire M5 assembly shall be fully mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.

C. Drive Chain: #10 qualified stainless steel chain rated to 90 lb. (41 kg) minimum breaking strength. Nickel plate chain shall not be accepted.

D. Accessories

1. Fascia:

a. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.

b. Fascia shall be able to be installed across two or more shade bands in one piece.

c. Fascia shall fully conceal brackets, shade roller and fabric on the tube.

d. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.

e. Notching of Fascia for manual chain shall not be acceptable.

2. Room Darkening Side and / or Sill Channels:

   a. Extruded aluminum with polybond edge seals and SnapLoc-mounting brackets and with concealed fastening. Exposed fasting is not acceptable. Channels shall accept one-piece exposed blackout hembar with vinyl seal to assure side light control and sill light control.

      1) MechoShade side channels, 1-15/16 inches (49.2 mm) wide by 1-3/16 inches (30.1 mm) deep, two-band center channels, 2-5/8 inches (66.6 mm) wide by 1-3/16 inches (30.1 mm) deep. The 2-5/8-inch (66.6 mm) double-center channels may be installed at center-support positions of multi-band-shade ElectroShades. MechoShade side channels 2-5/8 inch (66.6 mm) may be used as center supports for ElectroShades; shadebands up to 8 high. For shadebands over 8 feet (2438 mm), provide ElectroShade side channels.

      2) Color: To be selected from manufacturer’s standard colors.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that condition of substrates are satisfactory for installation of products.

B. Take site measurements to verify adequacy of spaces for lockers.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow proper clearances for window operation hardware.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

D. Engage Installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.05 SCHEDULE

A. Sunscreen Roller Shade:

1. Room 05-101 Sample Station

a. Size of window to cover: 2’ 4”W x 4’ 4”H.

1) Qty: 1

b. Size of door lite to cover: 2’ 0”W x 2’ 6”H.

1) Qty: 1

END OF SECTION 12494

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Accessories.

B. Related Requirements:

1. Section 03300 – Cast-in-Place Concrete: Concrete foundations.
2. Section 08330 – Architectural Overhead Coiling Doors: for coiling overhead doors in metal building systems.
3. Section 07210 – Pre-Engineered Building Insulation: Wall and roof insulation.
4. Section 07415 – Metal Roofing: Roof panels.
5. Section 07468 – Metal Siding: Exterior wall siding and soffits, interior liner panels.
6. Section 07600 – Flashing and Sheet Metal
7. Section 07714 – Gutters and Downspouts

1.02 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.03 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 03300 "Cast-in-Place Concrete."

B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

    a. Condition of foundations and other preparatory work performed by other trades.
    b. Structural load limitations.
    c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
    d. Required tests, inspections, and certifications.
    e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

    a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
    b. Structural limitations of purlins and rafters during and after roofing.
    c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
    d. Temporary protection requirements for metal roof panel assembly during and after installation.
    e. Roof observation and repair after metal roof panel installation.

3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

    a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
    b. Structural limitations of girts and columns during and after wall panel installation.
    c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
    d. Temporary protection requirements for metal wall panel assembly during and after installation.
    e. Wall observation and repair after metal wall panel installation.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

    a. Metal roof panels as specified in Section 07415.
    b. Metal wall panels as specified in Section 07468.

c. Metal soffit panels as specified in Section 07468.
d. Thermal insulation and vapor-retarder facings as specified in Section 07210.
e. Personnel doors and frames as specified in Section 08110.
f. Windows as specified in Section 08410.
g. Roof ventilators if required by mechanical.
h. Louvers if required by mechanical.

B. Building Calculations: Include building calculations for record, signed, dated, and sealed by an engineer licensed in the State of Texas. These calculations shall include base reactions where the building is to connect to the structural foundations. The reactions shall be provided in the form of Dead, Live, Roof Live, Rain, Snow, Wind (+/-), and Seismic (+/-); combinations of loads will not be accepted.

C. Anchor Calculations: The Contractor shall retain an engineer, licensed in the State of Texas, to provide calculations for the connections between the building and the foundations using the information provided in structural documents and the building calculated reactions. If changes are required structurally to the foundation the anchor designer shall notify the foundation design engineering firm of the required minimum edge dimension, effective embedment depth, or any other pertinent information needed for the design of the foundations.

D. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.

2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Show provisions for attaching mezzanines, roof curbs, service walkways platforms, and pipe racks.

3. Metal Roof and Wall Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

    a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
    b. Show wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.

4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:8):

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.

E. Samples for Initial Selection: For units with factory-applied finishes.

F. Samples for Verification: For the following products:
1. Accessories: Nominal 12-inch-(300-mm-) long Samples for each type of accessory.

G. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.

1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets indicating complete designations of every item required for each door or opening.
2. Keying Schedule: Detail Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

H. Delegated Design Submittals: For metal building systems.

1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For erector, manufacturer, land surveyor.

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or

effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

D. Erector Certificates: For qualified erector, from manufacturer.

E. Material Test Reports: For each of the following products:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

F. Source quality-control reports.

G. Field quality-control reports.

H. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.

I. Sample Warranties: For special warranties.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes and door hardware to include in maintenance manuals.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to IAS AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

B. Approved/Recommended Pre-Engineered Metal Building Manufacturers: Per request by the owner a list of approved PEMB manufacturers has been provided below.

1. Alliance Steel Buildings
2. American Buildings Co.
3. Behlen Manufacturing Co.
4. Butler Manufacturing Co.
5. Red Dot Buildings

2.02 SYSTEM DESCRIPTION

A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

B. Primary-Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
2. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.

C. End-Wall Framing:

1. Manufacturer's standard, for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns OR load-bearing end-wall and corner columns and rafters.

D. Secondary-Frame Type: Manufacturer's standard purlins and joists and flush-framed girts.

E. Eave Height: 16 feet (4.9 m).

F. Bay Spacing: As indicated on Drawings.

G. Roof Slope: 1 inch per 12 inches (1:12).

H. Roof System: As specified in Section 07415.

I. Exterior Wall System: As specified in Section 07468.

2.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

B. Wind Loads: Determine loads based on the following minimum design wind pressures:
1. Uniform pressure of 50 lbf/sq ft, acting inward or outward.
2. Uniform loads as indicated on Drawings.
3. Wind Load:
   a. Buildings: 120 mph (2018 IBC Exp. B).

C. Snow Loads: 5 lbf/sq ft.

D. Structural Performance: Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: As indicated on Drawings.
2. Deflection and Drift Limits (whichever is more stringent):

a. Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."
b. No greater than the following:

1) Purlins and Rafters: Vertical deflection of 1/240 of the span.
2) Girts: Horizontal deflection of 1/240 of the span.
3) Metal Roof Panels: Vertical deflection of 1/240 of the span.
4) Metal Wall Panels: Horizontal deflection of 1/240 of the span.
5) Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
6) Lateral Drift: Maximum of 1/200 of the building height.

E. Baseplates, anchors, and any other required foundation attachment mechanisms shall be designed to resist all loads imparted from the building to the foundations. Design requirements for minimum edge distance, effective embedment depth, etc. shall be provided to the foundation design engineers. Connections to the foundation shall all be pinned such that no moment is transmitted into the foundations from the building. See Concrete Specs and Structural General Notes for concrete strength for connection analysis and design.

F. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined according to ASCE/SEI 7.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.04 NOT USED

2.05 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

    a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Truss-Frame, Clear-Span Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
4. Exterior Column: Uniform depth.
5. Rafter: Uniform depth.

E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins:

    a. C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.
    b. Steel joists of depths indicated on Drawings.

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.
3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.
6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch (76-by-51-mm), fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

G. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

1. Type: As indicated.

H. Bracing: Provide adjustable wind bracing using any method as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50 (345); or ASTM A529/A529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.
2. Cable: ASTM A475, minimum 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

I. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation. A minimum of four (4) anchor rods shall be used to connect each column to structural concrete foundations.

J. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380). All members shall have a minimum thickness of 1/4" (0.25”).
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380). All members shall have a minimum thickness of 1/4" (0.25”).
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380). All members shall have a minimum thickness of 1/4" (0.25”).

4. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or HSLAS, Grades 45 through 70 (310 through 480).
5. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.
6. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80 (340 or 550); with Class AZ50 (AZM150) coating.

7. Joist Girders: Manufactured according to "Standard Specifications for Joist Girders," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing. All members shall have a minimum thickness of 1/4" (0.25”).
8. Steel Joists: Manufactured according to "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for secondary framing. All members shall have a minimum thickness of 1/4" (0.25”).

9. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 (ASTM A563M) carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

    a. Finish: Hot-dip zinc coating, ASTM F2329, Class C.

10. High-Strength Bolts, Nuts, and Washers, Grade A325 (Grade A325M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: Hot-dip zinc coating, ASTM F2329, Class C.

11. High-Strength Bolts, Nuts, and Washers, Grade A490 (Grade A490M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
12. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

    a. Finish: Mechanically deposited zinc coating, ASTM B695, Class 50.

13. Unheaded Anchor Rods: ASTM F1554, Grade 36.

    a. Configuration: Straight.
    b. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
    e. Finish: Hot-dip zinc coating, ASTM F2329, Class C.

14. Headed Anchor Rods: ASTM F1554, Grade 36.

    a. Configuration: Straight.
    b. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
    e. Finish: Hot-dip zinc coating, ASTM F2329, Class C.

15. Threaded Rods: ASTM A307, Grade A.

    a. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
    b. Washers: ASTM A36/A36M carbon steel.
    c. Finish: Hot-dip zinc coating, ASTM F2329, Class C.

K. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil (0.025 mm).

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil (0.013 mm) on each side.

2.06 METAL ROOF PANELS

A. As specified in Section 07415 "Metal Roofing".

B. Exposed-Fastener, Tapered-Rib, Metal Liner Panels: As specified in Section 07468.

2.07 METAL WALL PANELS

A. As specified in Section 07468 "Metal Siding". Finishes:

2.08 METAL SOFFIT PANELS

A. As specified in Section 07468 "Metal Siding".

2.09 THERMAL INSULATION

A. As specified in Section 07210 "Pre-Engineered Building Insulation".

2.10 PERSONNEL DOORS AND FRAMES

A. Swinging Personnel Doors and Frames:

1. As specified in Section 08110 "Steel Doors and Frames."

2.11 WINDOWS

A. Aluminum Windows:

1. As specified in Section 08410 "Metal Framed Storefronts."

B. Glazing: Comply with requirements specified in Section 08800 "Glazing."

2.12 OVERHEAD COILING DOORS

A. Overhead Coiling Doors:

1. As specified in Section 08330 "Architectural Overhead Coiling Doors".

2.13 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: As specified in Section 07415 "Metal Roofing".

C. Wall Panel Accessories: As specified in Section 07468 "Metal Siding".

D. Flashing and Trim: As specified in Section 07600 "Flashing and Sheet Metal”.

E. Gutters: As specified in Section 07714 "Gutters and Downspouts".

F. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.

2.14 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

2.15 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.03 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

    a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Steel Joists and Joist Girders: Install joists, girders, and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Joint Installation:
    a. Bolt joists to supporting steel framework using high-strength structural bolts unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
    b. Weld joist seats to supporting steel framework.

5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.04 METAL PANEL INSTALLATION, GENERAL

A. Reference Sections 07415 "Metal Roofing" and 07468 "Metal Siding".

3.05 METAL ROOF PANEL INSTALLATION

A. Reference Section "07415 "Metal Roofing".

3.06 METAL WALL PANEL INSTALLATION

A. Reference Section 07468 "Metal Siding".

3.07 METAL SOFFIT PANEL INSTALLATION

A. Reference Section 07468 "Metal Siding".

3.08 THERMAL INSULATION INSTALLATION

A. Reference Section 07210 "Pre-Engineered Building Insulation".

3.09 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 ADJUSTING

A. Roof Ventilators and Adjustable Louvers: After completing installation, including work by other trades, lubricate, test, and adjust units to operate easily, free of warp, twist, or distortion as needed to provide fully functioning units.

1. Adjust louver blades to be weathertight when in closed position.

3.12 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting:

1. 1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

    a. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
    b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to piping in Division 15, and on the Drawings and as indicated in the Piping Schedule.

C. The Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Drawings are not pipe construction or fabrication drawings. The CONTRACTOR shall prepare pipe spooling and fabrication drawings and shall submit them to the ENGINEER for review.

D. Where pipe layout details are not indicated on the Drawings, it is the CONTRACTOR's responsibility to develop the details necessary to design and construct piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

Division 15	Mechanical
01300	Submittals
09960	High-Performance Coatings
15006	Hangers and Supports for Process Piping
15145	Process Piping and Equipment Insulation
16150	Electric Heat Tracing

1.03 REFERENCES

A. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B31	Boiler and Pressure Vessel Code, Section 9
ASTM International (ASTM)	

ASTM A193	Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM F436	Hardened Steel Washers
ASTM F467	Standard Specification for Nonferrous Nuts for General Use
ASTM F468	Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
American Welding Society (AWS)	
AWS D1.1	Structural Welding Code
American Water Works Association (AWWA)	
AWWA C115	Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)

1.04 DEFINITIONS

A. Pipe, piping, pipe work, pipe system, piping system, or similar words, singular or plural shall mean and include, any type of pipes, tubes, fittings, valves, piping specialties, appurtenances, supports, restraints, anchors, coatings and linings and items related to piping.

B. Submerged piping, underwater piping, or similar words, shall include any piping located two feet above water surface in basins or tanks

C. Potable water or similar words shall mean and include any type of potable water or process water that be deemed potable after treatment processes.

D. Corrosive service shall mean and include in locations listed below:

1. Buried locations

2. Submerged locations or submerged piping.

3. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.

4. Chemical handling areas

5. Inside trenches, containment walls, and curbed areas

6. Locations indicated or designated in the contract documents.

1.05 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Pipe spooling and fabrication drawings shall indicate spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Welding Qualifications and Procedures

3. Pipe Supports: Submit pipe support fabrication drawings including calculations in accordance with Section 15006 - Hangers and Supports for Process Piping.

4. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation, and restraint system if applicable.

5. Thermoplastic Pipe Joints: Submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

6. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

7. Seals and Seating Materials: Submit elastomer material and manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

8. Modular Seals for Pipe: Manufacturer's catalog sheet showing materials and installation procedures.

9. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and

anchors and guides, including information on materials, temperature, and pressure ratings

10. Flexible Connectors: Submit pressure and thermal expansion calculations

C. Samples

1. Performing and paying for sampling and testing as necessary for certifications are the CONTRACTOR's responsibility.

D. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that each pipe will be manufactured subject to the fabricator's or a recognized Quality Control Program. An outline of the program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

1.06 MATERIAL DELIVERY, STORAGE AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

PART II - PRODUCTS

2.01 GENERAL

A. Extent of Work

1. Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Division 15 and as indicated.

2. Materials in contact with potable water or process water that be deemed potable after treatment processes shall be listed as compliant with NSF Standard 61.

B. Piping Supports

1. Pipes shall be adequately supported, restrained, and anchored in accordance with Section 15006 – Hangers and Supports for Process Piping, and as indicated.

C. Lining

1. Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections of Division 15, unless otherwise indicated.

D. Coating

1. Application, thickness, and curing of coating on buried pipe shall be in accordance with the applicable Sections of Division 15 and Section 09960 – High-Performance Coating, unless otherwise indicated.

2. Pipes above ground or in structures shall be coated in accordance with Section 09960 – High-Performance Coatings.

E. Pressure Rating

1. Piping systems shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

F. Inspection

1. Pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture, the ENGINEER shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

G. Tests

1. Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards.

2. The CONTRACTOR shall be responsible for performing material tests.

H. Welding Requirements

1. Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of AWS D1.1 - Structural Welding Code or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.

I. Welder Qualifications

1. Welding shall be performed by skilled welders and welding operators who have adequate experience in the methods and materials to be used.

2. Welders shall be qualified under the provisions of AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

4. Qualification testing of welders and materials used during testing is part of the Work.

2.02 PIPE FLANGES

A. General

1. Flanges shall be provided with flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated.

2. Flange faces shall be perpendicular to the axis of the adjoining pipe.

3. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for those pipes.

B. Pressure Ratings

1. 150 psig or less: Flanges shall conform to either AWWA C207 - Steel Pipe Flanges for Waterworks Service -Sizes 4 In. Through 144 In., Class D, or ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2. 150 psig to 275 psig: Flanges shall conform to either AWWA C207 Class E or Class F, or ASME B16.5, Class 150.

3. 275 psig to 700 psig: Flanges shall conform to ASME B16.5, Class 300.

4. Selection Based on Test Pressure

   a. Do not expose AWWA flanges to test pressures greater than 125 percent of rated capacity.

   b. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected.

C. Blind Flanges

1. Provide blind flanges in accordance with AWWA C207, or as indicated for miscellaneous small pipes.

2. Blind flanges for pipe diameters 12 inches and greater shall be provided with lifting eyes in the form of welded or threaded eye bolts.

D. Flange Coating

1. Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. Flange Fasteners

1. Unless otherwise shown on the drawings, or indicated in the applicable Sections of Division 15, Bolts and nuts shall conform to the following requirements;

   a. Threads shall be in accordance with ANSI/ASME B1.1, Class 2, UNC for bolt diameters 1" and smaller and UN8 for bolt diameters greater than 1".

   b. Bolts shall have heavy hexagon heads and heavy hexagon nuts. Length of studs shall provide a projection of not less than 0.25 inch and no more than 0.5 inch through the nut when it is drawn tight.

   c. Thread studs on flange connections are not permitted except where space restrictions preclude the use of standard bolts and where approved by the ENGINEER.

   d. Through bolt holes shall be drilled in accordance with the applicable flange standard.

   e. All bolts fastening metallic flanges shall be provided with plain washers installed under the nut. Washer materials shall be of the same material as the bolt. If the through bolt holes are drilled larger than the applicable standard by 1/8 inch in diameter or more, bolts shall be also installed with a plain washer under the bolt head as well.

   f. All bolts fastening non-metallic flanges shall be provided with plain washers installed under both the bolt head and nut.

   g. Washer materials shall be of the same material as the bolt.

   h. Anti-seize compound shall be used on carbon steel fasteners, and shall be Husk-ITT, Husky 2000.

   i. Anti-galling compound used for stainless steel fasteners in LOX, nitrogen injection, oxygen, ozone process/off-gas/vent and ozone contactor maintenance air service shall be DuPont "Krytox".

   j. Anti-galling compound used for stainless steel fasteners for other services shall be certified for potable water use and shall be Husk-ITT, Lube O'seal; Hercules, Real-Tuff; La Co, Slic-Tite.

2. Fastener Material Group Numbering System

    a. Flange fasteners shall conform to the following material standards and shall be categorized within the Fastener Material Schedule Groups as indicated:

        1) Material Group C1 (Carbon steel): ASTM A307 Grade B bolts, ASTM A563 Grade B nuts with ASTM F436 washers

        2) Material Group C2 (Carbon steel): ASTM A193 Grade B7 bolts, ASTM A194 Grade 2H nuts with ASTM F436 washers

        3) Material Group S1 (316 SS): ASTM A193, Grade B8M bolts, ASTM A194 Grade 8M nuts with Type 316 SS plain washers.

        4) Material Group S2 (304 SS): ASTM A193, Grade B8 bolts, ASTM A194 Grade 8F nuts with Type 304 SS plain washers.

        5) Material Group S3 (Hastelloy C-276): ASTM F468 N10276 bolts ASTM F467 N10276 nuts with type Hastelloy plain washers.

3. Fastener Material Group Numbers used in Non-Corrosive Service Applications

    a. (NOT USED)

4. Fastener Material Group Numbers used in Corrosive Service Applications

    a. All Flange fasteners shall be of Material Group S1 unless S2 and S3 are otherwise indicated on the drawings.

F. Insulating Flanges

1. Insulated flanges shall be provided with bolt holes 1/4-inch diameter greater than the bolt diameter.

G. Insulating Flange Sets

1. In order to prevent corrosion, insulating flange sets shall be furnished on all piping connections where two dissimilar metals are to be connected. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer.

2. For bolt diameters 1-1/2 inches or smaller, insulating sleeves and washers shall be one piece and shall be made of acetyl resin.

3. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic material.

4. Insulating flange sets materials used for fluids other than general water and wastewater shall be made of materials compatible with the fluid services.

5. Insulating gaskets shall be full-face.

H. Insulating Flange Manufacturer

1. JM Red Devil, Type E

2. Fluid Sealing Products, Inc.

3. Enpro Industries, Inc. (GPT)

I. Flange Gaskets

1. Gaskets for flanged joints used in general water and wastewater service shall be full faced type in accordance with AWWA C207, suitable for temperatures to 700 degrees F, a pH of one to 11, and pressures to 1000 psig.

2. Blind flanges shall be provided with gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange.

3. Ring gaskets will not be accepted unless otherwise indicated.

4. Unless otherwise indicated, flange gaskets up to 150 psi shall be EPDM sheet material, NSF 61 approved, Garlock, Style 98206-U (unbranded), or similar products from John Crane.

5. Unless otherwise indicated, flange gaskets up to 500 psi shall be aramid fiber with rubber binder material, NSF 61 approved, Garlock, Style 3760-U (unbranded), or similar products from John Crane.

6. Gaskets for flanged joints in PVC and CPVC piping used in general water and wastewater service shall be NSF 61 approved, full-faced, 1/8-inch thick, and made of fluoroelastomer having a durometer hardness of 50 to 70. Gaskets for pipe sizes up to 24-inch and 150 psi shall be Garlock Style XP or similar products from John Crane.

7. When the mating flange has a raised face, provide stainless steel flat ring gasket filler between the PVC flange and gasket and the adjacent flange.

8. Gaskets for flanged joints used in chemicals, hot air, ozone gas, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature. Consult gasket Manufacturer for recommended gasket material.

2.03 PIPE THREADS

A. Pipe threads shall be in conformance with ASME B1.20.1 - Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

B. Unless otherwise indicated, use metal FNPT and plastic MNPT for threaded pipe connections between metal and plastic pipes.

2.04 THREADED INSULATING CONNECTIONS

A. General

1. Threaded insulating bushings, unions, or couplings, as appropriate, shall be furnished for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials

1. Threaded insulating connections shall be constructed of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.05 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required in order to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures.

B. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 degrees F and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

C. Assemble the links using Type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

D. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

E. After the seal assembly is positioned in the sleeve, tighten the bolts against the pressure plates to expand the rubber links and form the watertight seal.

F. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

G. Modular Mechanical Seals Manufacturer

1. EnPro Industries Company (GPT), Link-Seal

2. Proco Products, Inc., Pen-Seal

2.06 PIPE INSULATION

A. Hot and cold liquid piping, flues, and engine exhaust piping shall be insulated as indicated and in accordance with the requirements of Section 15145 – Process Piping and Equipment Insulation.

B. No unprotected hot piping shall be within reach of operating personnel or other persons.

2.07 HEAT TRACING

A. Pipes subject to freezing shall be protected by heat tracing in accordance with the requirements of Section 16150 – Electric Heat Tracing.

B. Heat traced pipe shall be insulated as indicated and in accordance with the requirements of Section 15145 – Process Piping and Equipment Insulation.

2.08 GLASS LINING

A. General

1. Ductile iron or steel pipe and fittings shall be glass-lined where indicated.

2. The glass lining shall be suitable for handling sewage, primary sludge, digested sludge, dewatering filtrate and scum.

3. The lining shall be smooth, continuous, and suitable for prevention of grease and foam build-up.

4. The glass lining shall be capable of withstanding thermal shock of 350 degrees F (from 430 degrees F to 80 degrees F) without crazing, blistering, or spalling.

B. The glass lining shall consist of a vitreous material to meet or exceed the following criteria:

1. Unaffected by scraping with a sharp knife, simulating the effects of rodding.

2. Unaffected by the continuous application of live steam from a steam generator, immediately followed by a cold-water quench.

3. Unaffected by an 8-percent sulfuric acid solution at 148 degrees F for a 10-minute period.

4. A minimum thickness of 10 mils by micro test.

5. Spark-tested to be free of pinholes.

6. A hardness of 5 to 6 Mohs; and,

7. A density of 2.5 to 3.0 g/cu cm, measured by ASTM D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

C. Application

1. Cast or ductile iron pipes and fittings shall be bored or machined smooth in order to remove voids or protrusions.

2. Steel pipe shall be seamless pipe, with internal fitting welds ground smooth, slag holes ground out, re-welded, and ground smooth.

3. Interior surfaces shall be grit-blasted to white metal, and lining shall be fused onto chemically clean metal at above 1400 degrees F.

4. Welded flanges shall be factory-installed before lining.

5. Threaded flanges or cast and ductile iron pipes shall be installed after lining.

6. Pieces shall be sealed and tested prior to shipment.

7. Finish shall be subject to the ENGINEER's approval.

D. Manufacturer

1. Pfaudler, Inc.

2. A.O. Smith Corp.

3. U.S. Pipe

PART III - EXECUTION

3.01 GENERAL

A. This section specifies the general installation requirements for piping, valves, and related items and shall be installed in accordance with the manufacturer's technical data and printed instructions. Specific piping materials, systems, appurtenances, and related installation and testing requirements are specified in related sections of Divisions 01, and 15, and as noted on the Drawings, Pipe and Valve Schedules.

B. Piping shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access

to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

C. CONTRACTOR shall obtain the assistance of the pipe manufacturer to instruct the pipe fitters in the correct installation and support of the piping system. Valves and flanges attached to the pipe shall be provided with adequate supports.

D. Lined Piping Systems

1. The lining manufacturer shall take full responsibility for the complete, final product and its application.

2. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

3.02 INSTALLATION

A. Installation shall be free from defects. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true straight. Ends of threaded pipes shall be reamed and filed smooth. Groove ends shall be clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove. Fittings shall be equally cleaned before assembly.

B. Building gravity flow plumbing pipes shall be installed in a neat and workmanlike manner, in accordance with the prevailing plumbing and building codes. Pipes shall have the required slopes for proper drainage. Pipe locations inside buildings shall be coordinated with the rest of the Work to avoid interferences and to provide sufficient headroom. Installations shall be acceptable to the local plumbing inspector.

C. Supports and Anchors: Piping supports, thrust, and seismic restraints shall be provided where shown on the Drawing or were determined to be required in according to Section 15006 - Hangers and Supports for Process Piping. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Pipe shall be firmly supported with fabricated or commercial hangers or supports.

D. Piping Joints: Pipe joints requirements shall conform to the applicable piping sections of Division 15.

1. Threaded Joints: Pipe threads shall be full and cleanly cut with sharp dies. Not more than 3 threads shall remain exposed after installation.

2. Welded Joints: Welded joints shall conform to the specifications and recommendations of ASME B 31.1 - Power Piping. Welding shall be done by skilled and qualified welders. Pipe surface residues, oxides, and heat stains are to be removed from a field weld and the affected

areas adjacent by the use of stainless-steel wire brushes. For alloy and stainless-steel pipe, the post welding surfaces shall be cleaned with a pickle agent such as nitric/hydrofluoric acid solutions or pickle paste or equal, then complete removal of the agent by wash the surface thoroughly with clean water.

3. Flange Joints: Flanged joints shall be made with gaskets with bolts and nuts as specified. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

4. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conform to AWWA C 606 – Joints, Grooved and Shouldered Type. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

5. Push On Joints: Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

E. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

F. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment. Unless otherwise indicated for threaded pipe connections between metal and plastic pipes, use metal FNPT and plastic MNPT.

1. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

G. Isolation Joints / Dielectric Protection: Provide electrically isolate connections between dissimilar metal piping connections. Electrical checks shall be made to assure no contact is made between dissimilar metal piping elements.

1. Use dielectric couplings specially designed for the prevention of galvanic reaction between dissimilar metals.

2. For flanged connections, use stainless steel bolts with isolation bushings, washers, and full-face flange gaskets.

H. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph

of concrete construction in order to avoid damage to embedded raceways and reinforcing bars.

I. Coating: Exposed pipes shall be coated with a finish coat to the pipe manufacturer's standard protective coating, with the manufacturer's recommended prime coat and a finish coat in accordance with Section 09960 – High-Performance Coatings.

J. Low points in piping systems and drip legs in steam, gas, and air systems shall have drainage valves.

K. Care shall be taken to ensure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected.

3. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

4. Flange Bolts

a. Flange bolts shall be initially hand-tightened with the piping connections properly aligned.

b. Bolts shall be tightened with a torque wrench in a staggered sequence to the recommended torque for the applicable piping material per AWWA or manufacturer's recommendation. Care shall be taken to avoid over-torquing the bolts especially on plastic flanged joints.

c. Harness, thrust restraint, and tie rod bolts used for sleeve couplings, flange coupling adapters, or flexible joints shall be tightened gradually and equally at diametrically opposite sides until snug, in order to prevent misalignment and to ensure that all studs carry equal loads.

d. In order to prevent induced stress or misalignment, do not over-torque connections to adjoining pump or equipment. Flanges shall not be deformed nor cracked.

3.03 INSPECTION

A. After completion of the Work, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be in a clean and functional condition.

B. Inspection: Finished installations shall be carefully inspected for proper joints and supports, interferences, and damage to pipe, fittings, and coating. Temporary plugs and covers shall be removed from openings and floor drains. Defective Work shall be repaired to the satisfaction of the field ENGINEER or plumbing inspector.

3.04 FIELD TESTING FOR PRESSURE PIPING

A. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than two hours without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices as part of the Work.

B. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

C. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide pipe couplings indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to piping in Division 15, and on the Drawings.

C. The couplings, adapters and joints shall be provided with restraining devices to restrict pipe axial movement. Where the restraining devices and/or details are not indicated on the Drawings, it is the Contractor's responsibility to provide the devices/details necessary to restraint the piping system.

D. The Items specified in this section include the following:

1. Groove Couplings
2. Sleeve Couplings
3. Flanged Coupling Adapters
4. Dismantling Joints
5. Expansion Joints
6. Flexible Connectors
7. Transition Couplings.
8. Quick Disconnect Couplings
9. Tapping Sleeves
10. Miscellaneous Adapters

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
09960	High-Performance Coatings
15001	Piping General

1.03 REFERENCES

A. Reference Standards

American Iron and Steel Institute (AISI)	
ASTM A512	Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing
ASTM A513	Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 576	Steel Bars, Carbon, Hot Wrought, Special Quality
American Water Works Association (AWWA)	
AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C219	Bolted Sleeve-Type Couplings for Plain-End Pipe
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe: A Guide for Design and Installation

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Product submittals and shall be specifically identified with the applicable style or series designation, pressure rating and restraint system if applicable.

2. Couplings schedule or layout indicating where the couplings will be installed.

3. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and guides, including information on materials, temperature, and pressure ratings

4. Flexible Connectors: Submit pressure and thermal expansion calculations

C. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

1.05 MATERIAL DELIVERY, STORAGE AND PROTECTION

A. Piping couplings, adapters and joints accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

PART II - PRODUCTS

2.01 GENERAL

A. Extent of Work

1. Piping couplings, adapters, joints and accessories shall be provided in accordance with the requirements of the applicable Sections of Division 15 and as indicated.

2. The CONTRACTOR shall not be allowed to substitute any other type of coupling in lieu of the couplings as specified herein unless approved by the ENGINEER.

3. The CONTRACTOR shall assign the responsibility to the coupling manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.

B. Pressure Rating

1. Couplings, adapters, and joints shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

C. Seals

1. Seal elastomer materials shall be selected to be compatible with the fluid service, pressure, and temperature. They shall be composed of elastomeric-compound material that will not deteriorate from age under normal storage or use conditions.

2. Where couplings are used in water containing dissolved ozone residual or chloramines, seal material shall be Viton-A.

D. Coating

1. Couplings shall be lined and coated at the factory, unless otherwise indicated.

2. Coating shall be in accordance with the Section 09960 – High-Performance Coatings, unless otherwise indicated.

2.02 GROOVED TYPE COUPLINGS

A. General

1. Provide cast grooved type couplings where indicated, conforming to the requirements of AWWA C606 - Grooved and Shouldered Joints.

2. Grooved or banded piping shall conform to the coupling manufacturer's recommendations to suit the highest expected pressure.

   a. If grooved connections are used, the remaining thickness of pipe material after grooving shall be adequate to carry the load imparted to the joint. Joints for thin wall pipes shall be banded or welded with a collared end to fit coupling.

   b. Rolled pipe ends are not acceptable as a means of connection for metallic piping.

3. Equipment connections with mechanical-type couplings shall be provided with rigid grooved couplings or flexible type coupling with harness in sizes where rigid type couplings are not available, unless thrust restraint is provided by other means.

4. Couplings shall be electrically bonded.

5. For uniformity and compatibility of the piping components; grooving tools, grooved fittings, couplings, and valves shall be furnished by the same manufacturer as the coupling.

B. Grooved Type Couplings Manufacturer

1. Grooved couplings for ductile iron piping shall be provided with flush seal gaskets.

   a. Victaulic Company, Style 31 (flexible or rigid)

   b. Gustin-Bacon (banded or grooved)

2. Grooved couplings for steel piping

   a. Victaulic Company, Style 177 / 77 / W77 (grooved, flexible, or rigid)

   b. Victaulic Company, Style 107H / 07 / W07 or HP-70 (grooved, rigid)

   c. Gustin-Bacon (banded or grooved)

3. Grooved couplings for stainless steel piping

a. Victaulic Company, Style 489 (rigid)

b. Victaulic Company, Style 77S (flexible)

c. Gustin-Bacon (banded or grooved)

2.03 SLEEVE COUPLINGS

A. General

1. Provide sleeve couplings specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.

2. Couplings shall be constructed without pipe stop.

3. The middle ring shall be at least the same wall thickness as the pipe to which the coupling is connected and not less than 1/4-inch thick.

4. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. For standard sleeve couplings, the coupling shall be either 5 or 7 inches long for pipe diameters up to and including 30-inch and 10 inches long for pipe diameters greater than 30-inch. For long sleeve couplings, the coupling shall be 16 inches long for all pipe diameters.

6. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling.

C. Insulating Sleeve Couplings

1. Where insulating couplings are required, both ends of the coupling shall be provided with a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

D. Sleeve-Type Couplings Manufacturer

1. World Wide Metric, Inc. (Dresser), Style 38

2. Ford Meter Box Company, Inc., Style FC1 or FC3

3. Smith-Blair, Inc., Style 411

2.04 FLANGED COUPLING ADAPTERS

A. Provide flanged coupling adapters specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or ASTM A513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012 – Carbon Steel.

C. Flanged Couplings Adapter Manufacturer

1. Smith-Blair, Inc., Model 913

2. Dresser®, Style 128-W

3. JCM Industries, Inc., Model 303

2.05 DISMANTLING JOINTS

A. Provide dismantling joints products specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A 512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012 – Carbon Stee.

C. Dismantling Joints Manufacturer

1. Smith-Blair, Inc., Model 975

2. Dresser®, Style 131

3. JCM Industries, Inc., Model 309

2.06 EXPANSION JOINTS

A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures, accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints.

B. Expansion joints shall be provided with flanged ends and constructed of stainless steel, Monel, rubber, or other materials best suited for each individual service. Where expansion joints are used in water containing dissolved ozone residual or chloramines, provide Type 316 stainless-steel expansion joints.

C. Where bellows-type expansion joints are mounted near the suction nozzle of the pump, a stainless-steel internal liner shall be provided to minimize turbulence as the flow passes through the arches of the bellows.

2.07 FLEXIBLE CONNECTORS

A. Low-Temperature

1. Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated.

2. Flexible connectors for service temperatures up to 180 degrees F shall be flanged-reinforced neoprene or butyl spools, rated for a working pressure of 40 to 150 psig, or reinforced flanged duck and rubber, as best suited for the application.

3. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for a minimum 150-psig working pressure, unless otherwise recommended by the equipment manufacturer.

4. The connectors shall be a minimum of 9 inches long and provided with face-to-face flanges, unless otherwise indicated.

5. The final material selection shall be approved by the manufacturer.

B. High-Temperature (temperature exceeding 250 degree F (120 degree C)

1. Install flexible connectors in engine exhaust piping and where indicated.

2. Connectors shall be sufficient to compensate for thermal expansion and contraction and to isolate vibration between the engine and the exhaust piping system.

3. Connectors shall be stainless steel bellows-type, flanged, and rated for minimum 150 psig, 2000 degrees F.

2.08 TRANSITION COUPLINGS

A. Provide transition-coupling products specifically designed suitable for the fluid service and manufactured for the piping applications.

B. The transition couplings shall have function and design similar to the flexible couplings, joint and flanged coupling adapters for connecting piping having different outside diameters.

2.09 QUICK DISCONNECT COUPLINGS

A. Quick disconnect couplings shall be of the cam lock type (cam and groove type) consisting of a male adapter conforming to Specification MIL A-A-59326A. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Connections shall remain tight and leak proof up to full system pressures.

B. Each adapter shall be furnished with a dust cap complete with an 18-in long security chain of corrosion resistant material.

C. Unless otherwise indicated, the quick disconnect couplings shall be flanged connection to piping and materials shall be Type 316 stainless steel.

D. Quick connect couplings shall be as manufactured by LMC-Couplings; Dover Corporation; Ever-Tite Coupling Products.

2.10 TAPPING SLEEVES

A. Provide tapping sleeve products specifically designed suitable for the fluid service and manufactured for the piping applications

B. Unless otherwise indicated, the tapping sleeves shall be of full circumference band with flanged outlet connection sized to ANSI class

150. Material of construction for the body and fastener shall be stainless steel.

C. Gasket material: Nitrile (Buna-N) or EPDM.

D. Tapping sleeves shall be as manufactured by Smith-Blair Inc.; Romac Industries Inc.; Dresser®.

2.11 MISCELLANEOUS ADAPTERS

A. A special pipe adapter may be required to provide proper connection between different type of pipes and/or fittings. The adapter may be indicated on the Drawing with the pipe type or equipment. However, it is the Contractor's responsibility to ensure proper connection between various type of pipes and pipe appurtenances. Provide adapters as required whether specifically indicated or not.

B. Provide piping adapter products specifically designed suitable for the fluid service and manufactured for the piping applications.

PART III - EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall in accordance with the requirements of Section 15001 - Piping General.

B. The CONTRACTOR shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation.

C. The CONTRACTOR shall assign the responsibility to the couplings manufacturer to review the piping connection to the couplings and submit any modifications to the ENGINEER for review.

3.02 INSTALLATION

A. Where couplings are shown to connect piping to mechanical equipment such as pumps, compressors, and blowers, the piping shall be aligned with the equipment point of connection and shall be perpendicular to the axis of the flange or fitting for which the piping is to be connected.

B. The couplings or the piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment.

C. Restrained Joints on couplings, adapters, and joints

1. Couplings, adapters, and joints on pressure lines shall be harnessed unless thrust restraint is provided by other means.

2. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA M11, or as indicated.

3. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

4. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation in order to prevent misalignment of the pump imparted by the thrust within the piping system.

5. Other means of restraining the coupling such as set screws on piping will not be accepted.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide identification for the piping and valves, complete and in place, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
09960	High-Performance Coatings

1.03 REFERENCES

A. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME A13.1	Scheme for the Identification of Piping Systems

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals.

B. Shop Drawings:

1. Provide a list of the suggested wording for each pipe label and valve tag, prior to fabrication.
2. Product Data
3. Samples
4. Manufacturer's installation instructions
5. Operation and Maintenance Data
6. Warranty

PART II - PRODUCTS

2.01 EXPOSED PIPING OR ABOVE GROUND PIPING IDENTIFICATION

A. Pipe markers, type as indicated below, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

1. Marker Type

    a. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

    b. Marker Area: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

    c. Lettering: The letter sizes corresponding to the applicable outside pipe diameter shall be used.

Nominal Pipe Diameter	Lettering Size
0.75 inches to 1.25 inches	0.5 inch
1.5 inches to 2 inches	0.75 inch
2.5 inches to 6 inches	1.25 inch
8 inches to 10 inches	2.5 inch
Over 10 inches	3.5 inch

    d. Arrows: At least one arrow at each marker area, showing direction of flow.

B. Pipe 1-inch diameter and smaller or pipe not suitable for the marker type listed above shall be identified with aluminum or stainless-steel pipe identification tags with stamped-in ¼" high identification lettering.

C. Manufacturer

1. Seton Identification Products, Opti Code Pipe Markers

2. Grainger, Inc.

3. Marking Services, Inc.

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground Warning Tape

1. Material:

    a. Polyethylene tape or polyolefin film. The material and ink shall be chemically inert and shall not degrade when exposed to acids, alkalis and other destructive substances commonly found in soil.

b. 6” wide tape with a minimum 4 mil thickness.

c. Message: “CAUTION, LINE BURIED BELOW” with the name of the fluid service in black lettering on a colored background.

1) Water: Blue

2) Sewer: Green

3) Gas and other services: Yellow

4) Telephone: Orange

5) Other services: colors as approved by the OWNER.

2. Manufacturer

a. Reef Industries, Inc.

b. Seton Identification Products

c. T. Christy Enterprises, Inc.

B. Tracer Wire

1. Material:

a. Solid copper conductor with 30 mil HMWPE.

b. 10 gauge or thicker wire.

2. Manufacturer

a. Kris-Tech Wire

b. Corrpro Companies, Inc.

C. Witness Markers

1. Material:

a. UV resistant glass fiber and resin reinforced thermosetting composite material.

b. Constructed as a single pipe with pointer at the bottom end.

c. Message of the markers “CAUTION, LINE BURIED BELOW” with the name of the fluid service, and the following information:

1) Phone number for underground service alert.

2) Phone number for OWNER in case of emergency.

3) Application station number and offset information if marker is not directly over the pipe.

4) Name of buried appurtenance or fitting if applicable.

2. Manufacturers

a. Carsonite® Composite Utility Marker

b. Berntsen International, Inc.

2.03 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the CONTRACTOR shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the system indicated herein.

2.04 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Valves and sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to the valves or short pipes.

C. Wording on valve tags shall describe the exact function of each valve (e.g., "HWR-BALANCING," "CLS THROTTLING", "RAS-PUMP SHUT-OFF," etc.) and include the valve number as indicated in the Contract Drawings. Wording on small pipes shall describe the contents of the pipe.

2.05 PIPE COATING

A. Unless otherwise indicated, pipe coating shall be in conformance with Section 09960 – High-Performance Coatings.

PART III - EXECUTION

3.01 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.02 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.03 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.
2. At least once in every room.
3. Within 2 feet of turns, elbows, and valves.
4. On the upstream side of tees, branches, and other distribution points.
5. On both sides of walls and floors through which the piping passes.

3.04 ABOVE-GRADE PIPE IDENTIFICATION MARKER AND LETTERING COLORS

A. The table below meets the requirements of ASME A13.1 and OSHA

Service	Lettering	Background
Fire Quenching Fluids (water, foam, carbon dioxide, halon, etc.)	White	Red
Toxics and corrosive fluids	Black	Orange
Flammable fluids	Black	Yellow
Combustible Fluids	White	Brown
Water and low hazard fluids	White	Green
Nonflammable and nontoxic gases	White	Blue
Reclaimed Water	White	Purple

3.05 IDENTIFICATION COLORS

A. Conform to the following color codes.

Pipe Contents	Pipe Color	Marker Color	Letter Color
Service			
Air	Light green	blue	white
ARF Influent	Brown	green	white
ARF Effluent	Brown	green	white
Drain	Dark grey	green	white
Non-Potable Water	Purple	green	white
Stainless Steel Pipe	None	None	black
Potable Water	Light Blue	green	white
Sludge	Brown	orange	black
Natural Gas	Red	yellow	black
Chlorine	Yellow	orange	black
Sulfur Dioxide	Lime Green with Yellow Bands	orange	black
Sewage	Grey	green	white
Heated Water	Blue	green	white
Power Conduit	NEC Electrical Code		
Reclaimed Water	Purple	NA	Black
Gray Water	Purple	NA	Yellow
Instrument Air	Light green with Dark Green Bands	blue	White
Liquid Alum	Yellow with Orange Bands	orange	black
Alum (Solution)	Yellow with Green Bands	orange	black

Pipe Contents	Pipe Color	Marker Color	Letter Color
Service			
Ferric Chloride	Brown with Red Bands	orange	black
Polymers	White with Green Bands	orange	black
Ozone	Stainless Steel with White Bands	orange	black
Raw Water	Tan	green	white
Effluent after Clarification	Dark Green	green	white
Vent	Yellow	blue	white

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide pipe supports, hangers, guides, and anchors, complete and in place, as indicated in accordance with the Contract Documents.

B. Where pipe support systems are not indicated on the Drawings, the CONTRACTOR shall design and provide the supports in accordance with this Section. The absence of pipe supports and details on the contract drawings does not relieve the CONTRACTOR of responsibility for sizing and providing the pipe supports.

C. The provisions of this Section shall apply to piping in Division 15.

1. The CONTRACTOR shall provide supporting devices for supporting and restraining piping as indicated on the Drawings. Where pipe support devices and/or restraining details are not indicated on the Drawings, it is the CONTRACTOR's responsibility to develop the details necessary to support and restraint the piping for a complete and functional pipe support system.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
05500	Metal Fabrications
09960	High-Performance Coatings
15001	Piping General

1.03 REFERENCES

A. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASTM International (ASTM)	
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
Manufacturers Standardization Society of the Valve and Fittings	

Industry (MSS)	
ANSI/MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

1.04 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals.

B. Shop Drawings

1. Submit Shop Drawings which shall include the following information:

a. Drawings of pipe supports, hangers, anchors, and guides.

b. Pipe support schedule or layout indicating where the supports will be installed.

PART II - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Code Compliance

1. Piping systems and pipe connections to equipment shall be properly anchored and supported in order to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, and probable forces applied during construction as well as stresses on piping, equipment, and structures.

2. Supports and parts thereof shall conform to the requirements of ASME B31.1 - Power Piping – Chapter II, Part 5 -Expansion, Flexibility, and Pipe Supporting Element and design the pipe supporting elements in accordance with the rules of MSS SP-58 -Pipe Hangers and Supports – Materials, Design and Manufacture, except as supplemented or modified in this Section.

3. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members

1. Wherever possible, pipes shall be supported from structural members.

2. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the CONTRACTOR.

3. Supplementary members shall be in accordance with the requirements of the Building Code and the American Institute of Steel Construction and shall be as acceptable to the ENGINEER.

C. Pipe Hangers

1. Pipe hangers shall be capable of supporting the pipe in operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment.

2. Hangers shall have a means of vertical adjustment after erection.

3. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe.

4. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves shall include hydraulic shock suppressors.

5. Hanger rods shall be subjected to vertical loading only.

D. Hangers Subject to Lateral or Axial Movement.

1. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement.

2. Where lateral or axial pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold-to-hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers

1. Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping.

2. Spring-type hangers shall be sized per the manufacturer's printed recommendations and for the loading conditions encountered.

3. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate the compression of the spring.

4. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

F. Thermal Expansion

1. Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or expansion joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely away from the anchored points.

2. Components shall be structurally suitable to withstand the imposed loads.

G. Heat Transmission

1. Supports, hangers, anchors, and guides shall be designed and insulated such that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports

1. Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping

1. Freestanding pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to support frames fabricated from angles, channels, or I-beams anchored to the structure.

2. Exterior, freestanding overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, or with horizontal, welded steel angles, and U-bolts or clamps securing the pipes.

J. Materials of Construction

1. Pipe support assemblies, including framing, hardware, and anchors, shall be of steel construction, galvanized after fabrication, unless otherwise indicated.

2. Submerged supports, as well as piping, conduits, and equipment in hydraulic structures located two feet above water level, shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel, unless otherwise indicated.

3. Piping in chemical and corrosive service areas shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

4. Corrosive service areas are indicated in section 15001 – Piping General, 1.2 Definitions - Corrosive Service.

K. Point Loads

1. Meters, valves, heavy equipment, and other point loads on PVC, FRP, or other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations, in order to avoid undue pipe stresses and failures.

2. In order to avoid point loads, the supports on PVC, FRP, or other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields for general service and Type 316 stainless steel shields for chemical or corrosive areas.

L. Concrete Anchors

1. Unless otherwise indicated, concrete anchors for pipe supports shall be according to the following table: consult the ENGINEER for any anchor applications not appearing on the table.

2. Anchor embedment shall be in accordance with the requirements of Section 05500 – Metal Fabrications.

Pipe Support Application	**Type of Concrete Anchor**
New Concrete	Use embedded concrete insert anchors on a grid pattern. Use Grinnell (Anvil International), Tolco.
Existing Concrete	Use non-shrink grouted anchors, expansion anchors, or epoxy anchors. Epoxy anchors are not permitted for vertical hanging applications or where sustained tension is exerted on the anchor. Exceptions: Expansion anchors and epoxy anchors are not permitted for pipe supports subject to vibrating loads. Epoxy anchors are not permitted where the concrete temperature is in excess of 100-degree F or higher than the limiting temperature recommended by the manufacturer.
Vibratory Loads and High-Temperature Conditions	Use non-shrink grouted anchors.

2.02 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads.

B. Where pipe spacing are indicated on the Drawings and are referenced to a Standard Detail, that requirement shall take preference over the general requirements of this section.

C. Pipe support spacing shall not exceed the maximum indicated spans. Piping with grooved joint couplings, flexible joints, and bend fittings shall be balanced supported by a minimum of two pipe supports per pipe length, one at near each joint/fitting.

D. For temperatures other than ambient temperatures or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations.

E. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of loading effects.

F. Steel Pipe

1. Where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing below.

2. Support Spacing for standard wall or heavier welded steel, stainless steel or alloy steel pipe.

Nominal Pipe Diameter, Inches	**Maximum Span, ft (Water Service)**	**Maximum Span, ft (Gas or Vacuum Service)**
1/2	6	7
3/4 and 1	8	9
1-1/4 to 2	10	12
3	12	14
4	14	15
6	16	18
8 and 10	18	20
12 and 14	20	24
16 and 18	22	26
20 and greater	24	30

G. Ductile Iron Pipe

1. Install supports for ductile iron pipe in accordance with the recommendations of the Ductile Iron Pipe Research Association (DIPRA) Design of Ductile Iron Pipe on Supports.

2. As a minimum, where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing indicated in the following schedule:

Nominal Pipe Diameter, inches	Support Configuration
All diameters	two supports per pipe length, with one of the two supports located at a joint

H. Schedule 80 PVC and CPVC Pipe

Nominal Pipe Size, inches	100 °F and below	101 to 120 °F	121 to 140 °F
1	5	3.5	3
1-1/2	5.5	3.5	3.5
2	6	4	3.5
3	7	4.5	4
4	7.5	5	4.5
6	9	6	5
8	9.5	6.5	5.5
10 and larger	10	7	6

I. Other Pipe Materials

1. Support spacing for pipe constructed of other materials shall be based on design temperature and in accordance with the pipe manufacturer's recommendations.

2.03 MANUFACTURED SUPPORTS

A. Stock Parts

1. Where not specifically indicated, designs that are generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.

2. Such parts shall be locally available, new, of best commercial quality, and designed and rated for the intended purpose.

B. Manufacturers

1. Basic PSA, Inc.

2. Bergen-Paterson Pipe Supports Group

3. Grinnell

4. Power Piping Company

5. TOLCO (Eaton B-Line)

2.04 COATING

A. Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and shall receive protective coatings in accordance with the requirements of Section 09900 – High Performance Coatings.

PART III - EXECUTION

3.01 INSTALLATION

A. General

1. Pipe supports, hangers, brackets, anchors, guides, and inserts shall be installed in accordance with the manufacturer's printed instructions and per ANSI/MSS SP-58 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

2. Embedded concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. Appearance

1. Pipe supports and hangers shall be positioned in order to produce an orderly, neat piping system.

2. Hanger rods shall be vertical, without offsets.

3. Hangers shall be adjusted to line up groups of pipes at the proper slope for drainage and venting, as close to ceilings or roofs as possible, and without interference with other Work.

3.02 FIELD FABRICATION

A. Quality Control

1. Field fabricated pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available.

2. Hangers and supports shall be neat in appearance without sharp corners, burrs, or edges.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The Contractor shall provide stainless steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
15001	Piping General
15006	Hangers and Supports for Process Piping
15145	Process Piping and Equipment Insulation

1.03 REFERENCES

1. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.9	Factory-Made Wrought Steel Butt-Welding Fittings
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM A312	Seamless and Welded Austenitic Stainless-Steel Pipe
ASTM A380	Cleaning, Descaling, and Passivation of Stainless-Steel Parts, Equipment, and Systems
ASTM A403	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409	Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service
ASTM A778	Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM A967	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
American Water Works Association (AWWA)	
AWWA C606	Grooved and Shouldered Joints

1.04 SUBMITTALS

A. In addition to the submittals required by Section 01300 – Submittals and Section 15001 – Piping General, provide proposed post welding cleaning method (including precleaning, descaling, chemicals to be used) or mechanical descaling method and final cleaning/passivation.

B. Provide written certification that the pipe as supplied are in accordance with ASTM A409 or ASTM A778, If the pipes are provided, Supplemental testing is not required.

PART II - PRODUCTS

2.01 PIPE MATERIAL

A. All welded stainless steel piping, including flanges and other appurtenances shall be the low carbon "L" type stainless to avoid carbide precipitation.

B. Unless otherwise indicated, stainless steel pipe shall be in accordance with ASTM A312 - Seamless and Welded Austenitic Stainless-Steel Pipe, Type 304L/316L seamless, of the schedules indicated. Stainless steel pipe 12 inches in diameter and larger shall be in accordance with ASTM A409 - Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service or ASTM A778 - Welded, Unannealed Austenitic Stainless Steel Tubular Products, Type 304L/316L, of the schedules indicated, with welded or flanged joints. Piping less than 3 inches in nominal diameter shall have a minimum wall thickness not less than the Schedule 40S.

2.02 PIPE JOINTS

A. Stainless steel pipe for sizes 2-1/2 inches and smaller shall have threaded ends with NPT threads made up with Teflon tape. Stainless steel pipe 3 inches and larger and where indicated shall have welded joints with socket-welding fittings, butt-welding fittings, or socket welding flanges. Stainless steel flanges shall have stainless steel bolts and nuts. Where indicated, stainless steel pipe shall have grooved ends for shouldered couplings, except that no pipe with less than Schedule 40 wall thickness shall be grooved. Where indicated, stainless steel pipe shall have plain ends for sleeve-type couplings.

B. Threaded joints (all sizes) are not allowed for the following fluid services: sodium hydroxide, sulfuric acid, oxygen, and other fluid services indicated in pipe schedule.

2.03 FITTINGS

A. Threaded Fittings: Forged stainless steel fittings conforming to ASME B16.11 - Forged Fittings, Socket-Welding and Threaded, Type 304L/316L.

B. Socket-Welding Fittings: Forged stainless steel fittings conforming to ASME B16.11, Type 304L/316L.

C. Butt-Welding Fittings: Wrought stainless steel butt-welding fittings conforming to ASTM A403 - Wrought Austenitic Stainless Steel Piping Fittings, and ASME B16.9 - Factory-Made Wrought Steel Butt-Welding Fittings, Type 304L/316L.

D. Grooved Fittings: Wrought stainless steel grooved fittings conforming to ASTM A403 and ASME B16.9, with grooving conforming to AWWA C606 - Grooved and Shouldered Joints, Type 304L/316L.

E. Flanged Fittings: Type 304L/316L stainless steel flanged fittings and flanges conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings.

F. Pressure Class: Unless otherwise indicated, fittings shall be in accordance with the pressure classes called for in the Piping Schedule. Where not indicated, the fittings shall have the same pressure rating as the pipe.

2.04 CLEANING

A. Stainless steel pipe and fittings shall be pickled at the point of manufacture, scrubbed, and washed until all discoloration is removed in accordance with ASTM A380 - Cleaning, Descaling, and Passivation of Stainless-Steel Parts, Equipment, and Systems or ASTM A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

2.05 LININGS AND COATING

A. Air service pipe:

1. Lining: None

2. Coating: None

2.06 INSULATION

A. For new process aeration piping, provide insulation in accordance with Section 15145 – Process Piping and Equipment Insulation and as indicated in the Contract Drawings. Areas to be insulated include all new piping, fitting and flanges located outdoors on walkways.

PART III - EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall be in accordance with the requirements of Section 15001 - Piping General.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Internal acoustical insulation and external thermal insulation for metal air ductwork systems.

1.02 REFERENCES

A. ASTM International (ASTM):

1. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

2. G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

1.04 QUALITY ASSURANCE

A. Comply with SMACNA ducting construction standards and the specified requirement, whichever is more stringent.

PART II - PRODUCTS

2.01 INTERNAL DUCTWORK INSULATION

A. Manufacturers: One of the following or equal:

1. Johns Manville, Linacoustic RC flexible duct liner or Permacoat Linacoustic R-300 rigid duct liner.

2. Owens Corning, QuietR flexible duct liner or Fiberglass rigid duct liner.

B. Type: Flexible or board type duct liner with 1 coated surface meeting the following:

1. Thickness: As required to achieve the following R-values:

    a. For interior ducting in ceiling plenums, attics or other spaces as indicated on the drawings, provide minimum thickness to meet an installed value of R-6.

2. Temperature range: 40 to 250 degrees Fahrenheit.

3. Density: 1.5 pounds per cubic foot.

4. Thermal conductivity: 0.25 Btu-inch per hour per square foot per degree Fahrenheit at 75 degrees Fahrenheit.

5. Fire hazard classification in accordance with ASTM E84:

    a. Flame spread: 25.

    b. Smoke developed: 50.

6. Service conditions: Velocities to 2,500 feet per minute.

7. Acoustical performance: NRC of 0.55 minimum.

8. Bacterial growth: None in accordance with ASTM G21.

C. Edge treatment: Provide leading edges with galvanized metal nosing; seal other edges with manufacturer's recommended edge treatment.

PART III - EXECUTION

3.01 INSTALLATION

A. Internal ductwork insulation:

1. Provide rigid insulation on rectangular ducts carrying conditioned air that pass through outdoor or unconditioned spaces as indicated on the Drawings.

2. Install with coated surface facing inside of duct; attach with adhesive to duct and provide fasteners spaced at not to exceed 12 inches transverse (perpendicular) to flow and 18 inches parallel (longitudinal) to flow; provide fasteners within 3 inches of transverse edges and 4 inches of longitudinal edges.

3. Follow manufacturer's published installation instructions.

4. Install metal nosing on leading edges and seal other exposed edges with manufacturer's edge treatment.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide pipe and equipment insulation, complete and in place, in accordance with the Contract Documents.

B. Work to be insulated includes outside aeration process piping as described herein and outside NPW piping 2" and smaller.

C. In addition to the insulation indicated, the CONTRACTOR shall insulate hot and cold piping that could be hazardous to personnel upon contact.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals

1.03 REFERENCES

1. Reference Standards

ASTM International (ASTM)	
ASTM B209	Aluminum and aluminum alloy sheet and plate
ASTM C522, Type II	Cellular Glass Type
ASTM C534	Preformed flexible elastomeric cellular thermal insulation in sheet and tubular form
ASTM C547	Mineral Fiber Pipe Insulation
ASTM C553	Mineral Fiber Blanket Insulation
ASTM C612	Mineral Fiber Board Insulation
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials
ASTM E96	Water Vapor Transmission of Materials

1.04 SUBMITTALS

A. Submit complete Shop Drawings of thermal insulation, with Manufacturer's data on materials, covering, jackets, and finish, in accordance with the requirements of Section 01300 – Submittals.

B. Furnish the following certifications:

1. Certification from the heating system installer that the insulation has been installed in accordance with the Manufacturer's recommendations.

PART II - PRODUCTS

2.01 GENERAL

A. Components of the insulation, including covering, mastics, and adhesives, shall have a flame-spread rating of not greater than 25 and a smoke development rating of not greater than 50.

B. Ratings shall be as established by tests in accordance with ASTM E 84, and the above federal and commercial specification standards.

C. Insulation shall be applied in strict accordance with the Manufacturer's instructions.

2.02 PIPING INSULATION FOR PIPING 2" AND SMALLER

A. Piping insulation shall be tubular type or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints flanges and other connections shall be segmented section, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

B. Except as indicated otherwise, piping shall be insulated with heavy density, unfaced, fiberglass pipe insulation.

C. Pipe insulation shall have an average density of 3.5 pounds per cubic foot or greater, and its conductivity (k) shall not exceed 0.23 BTU-inch per (hour) (square foot) (degree F) at a mean temperature of 75 degrees F.

D. Supporting Hangers

1. For 3-inch piping and larger, the insulation shall be protected at supporting hangers by the suitable hollow steel protection saddles, filled with loose glass fiber insulation as indicated.

2. For piping smaller than 3-inch, place 1/16-inch thick sheet metal shims between the insulation and the supporting hanger; the shim shall be at least 6 inches long.

3. The insulation shall be oversized for installation over electric heating cable.

4. The insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn.

5. Fittings and valves shall be covered with the same material as the pipe, cut in segments to fit snugly without open spaces, held in place with copper wire or cement, and then covered with the same jacketing material as the pipe.

6. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-retarder mastic before installation of the finish jacket.

7. The pipe insulation and vapor-barrier shall be continuous through hangers and supports.

8. Where insulation is indicated for the top-half segment of pipe, insulation at support locations shall be of the same density.

9. The bottom-half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb/cu ft.

10. Provide thermal shields for hot blower discharge and motor heat reject piping.

E. Jacketing

1. A final covering of the insulation for piping shall be of 0.016-inch thick smooth aluminum or stainless steel, preformed jacketing with a factory-attached moisture barrier.

2. Valves, flanges, fittings, and ends of insulation shall be covered with a pre-molded, precision-formed, high-low temperature smooth aluminum or stainless steel fitting cover or end cap, or equivalent preformed unit to match the piping insulation jacket.

3. The pre-molded covers shall be sized to receive the same thickness of insulation as used on the adjacent piping and shall be sized to cover and protect the insulated fitting.

4. Joints shall be sealed with vapor-retarder mastic or solvent welding to provide a continuous air- and weather-tight joint.

5. Strapping shall be 1/2-inch wide, aluminum or stainless steel.

6. Metal jackets shall be secured with 0.020 by ¾ inch aluminum or stainless steel expansion bands.

F. Standard Temperature Insulation

1. Standard temperature insulation shall be used for process, cold and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F.

2. Pipe insulation and jacketing shall be applied to piping where indicated, including associated fittings, flanges, and valves.

3. Standard temperature insulation shall be of the cellular glass Type II or fiberglass type I, Grade A.

G. Manufacturers

1. Armstrong Contracting and Supply Corp.

2. Certain-Teed Corporation

3. Johns Manville

4. Owens-Corning

5. P.P.G. Industries, Inc.

2.03 AERATION PIPING INSULATION

A. Provide acoustical-thermal insulation on discharge process piping and heat reject piping, including fittings, flanges, valves, couplings, meters, silencers, and appurtenances, located outside the building. Piping inside the building does not require insulation.

B. Acoustical Insulation

1. Acoustical insulation shall consist of 1" fiberglass pipe insulation, 1 lb. mass laded vinyl jacket, and aluminum jacket.

2. The fiberglass barrier shall have a temperature rating to 350 degrees F, and shall be Micro-Lok HP as manufactured by Johns Manville.

3. The acoustical insulation shall overlap at least 2 inches in both the transverse and longitudinal directions and shall be installed to avoid sagging or gapping.

C. Scrim

1. The acoustical insulation shall be held in place by the use of scrim fabric at least 6 inches wide.

2. Provide at least 2 wraps of scrim per length of acoustical insulation.

3. The scrim shall be 5 x 5-thread-count fiberglass mesh, with a thread thickness of 0.03 inch, and weighing 5.8 ounces per square yard.

4. Scrim shall be Alpha Associates Luben 8405.

D. Thermal Insulation

1. The acoustical insulation shall be covered by a fiberglass thermal insulation and fiberglass lagging fabric.

2. The thermal insulation shall have an average density of 3.5 pounds per cubic foot or greater, and its conductivity (k) shall not exceed 0.27 BTU-inch per (hour) (square foot) (degree F) at a mean temperature of 100 degrees F.

3. The thermal insulation shall be as manufactured by Johns Manville.

E. Jacketing

1. A final covering of the insulation for piping shall be of 0.016-inch thick aluminum or stainless steel preformed jacketing with a factory-attached moisture barrier.

2. Valves, flanges, fittings, and ends of insulation shall be covered with a pre-molded, precision-formed, high-low temperature smooth aluminum fitting cover or end cap, or equivalent preformed unit to match the piping insulation jacket.

3. The pre-molded covers shall be sized to receive the same thickness of insulation as used on the adjacent piping and shall be sized to cover and protect the insulated fitting.

4. Joints shall be sealed with silicone mastic or solvent welding to provide a continuous air- and weather-tight joint.

5. Strapping shall be 1/2-inch wide, Type 3003 aluminum or stainless steel.

6. Jackets shall be secured with 0.020 by ¾ inch type 304 stainless steel expansion bands.

F. Compression Couplings and Expansion Joints

1. Compression couplings and expansion joints on piping shall be covered as indicated, using rigid insulation block.

2. The insulation block shall be composed of hydrous calcium silicate and segmented to wrap around the piping.

G. Manufacturers

1. Manville, Thermo 12

2. Owens-Corning, Kaylo 10

H. Valves and flanges shall be covered in a similar manner to the adjacent piping.

I. Density and Thickness

1. Density: 1.5 lbs per cu ft

2. Thickness: 2 inches, as indicated

J. The duct/pipe wrap insulation shall consist of a blanket of glass fibers factory-laminated to a reinforced foil/ kraft (FRK) vapor retarder facing, with a 2-inch-wide (minimum) stapling and taping flange on one edge.

K. The duct/pipe wrap insulation shall provide installed R-values as indicated in the following table:

Density, lbs/cu.ft	**Pipe Size, nominal, inches**	**Nominal Thickness, inches**	**R-Value [1,2], (hour)(sq.ft)(degree F) per BTU**
1.50	4 inches and smaller	2	6.0
1.50	5 inches and greater	2	8.0

[1] *at 75 degrees F mean temperature*

[2] *assumes 25 percent compression of insulation*

PART III - EXECUTION

3.01 GENERAL

A. Insulation and liners shall be installed by a qualified insulation CONTRACTOR in strict accordance with the Manufacturer's recommendations.

3.02 PIPING INSULATION

A. Piping, fittings, and valves to be insulated shall be clean and dry prior to installation of insulation.

B. Piping indicated to be insulated shall be completely insulated inside structures, except where indicated otherwise.

3.03 INSULATION OF STRAIGHT DUCT AND FITTINGS

A. Before applying the duct wrap, air ducts shall be clean, dry and tightly sealed at joints and seams.

B. Portions of the duct designated to receive duct wrap shall be completely covered with duct wrap.

C. Remove a 2-inch piece of insulation from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.

D. Install duct wrap insulation with facing outside such that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap.

E. Adjacent sections of the duct wrap insulation shall be tightly butted and overlapped with the 2-inch stapling and taping flap.

F. If the duct is rectangular or square, install insulation such that it is not excessively compressed at corners.

G. Seams shall be stapled approximately 6 inches on center, using 1/2-inch steel outward clinching staples.

H. Seams and joints shall be sealed with pressure-sensitive tape matching the insulation facing (either plain foil or FRK backing stock) or glass fabric and mastic.

I. Cloth duct tape of color or finish using reclaimed rubber adhesives will not be accepted for use on duct wrap insulation.

J. Where rectangular ducts are 24 inches or greater in width, the duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18-inch centers (maximum) to prevent the insulation from sagging.

K. Where a vapor retarder is indicated, seal tears, punctures and other penetrations of the duct wrap facing using one of the above methods to provide a vapor-tight system.

L. Damaged Insulation

1. The CONTRACTOR shall replace insulation that has been damaged or removed by modifications to the existing ductwork.

   The replacement insulation shall be new and joints between new and existing insulation shall be made water-tight.

3.04 FIBERGLASS INSULATION

A. Fiberglass insulation shall be securely held in place before the final covering is applied.

B. A scrim fabric, similar to a 20 x 10 thread count mesh and 100 percent fiberglass, shall be pasted in place to hold the pipe insulation securely to the pipe.

C. The scrim fabric shall be at least 4-inches wide, with at least 2 applications per length of pipe insulation, and one at each joint.

3.05 JACKETING

A. Joints shall be neatly finished with no ragged ends.

B. When finished, the covering shall show no exposed staples or other binding used during installation.

C. Staples, if used, shall be stainless steel.

3.06 LAGGING FABRIC

A. The final lagging fabric shall be neatly pasted in place with a 3-inch longitudinal overlap using a Luben No. 9 adhesive.

B. Each transverse joint shall have a 3-inch butt strip of the same fiberglass fabric.

C. Final joints shall be neatly finished with no ragged ends and the covering shall present a neat, uniform surface when finished.

D. The fabric shall show no exposed staples or other binding used during construction; staples, if used, shall be stainless steel.

3.07 COMPRESSION COUPLINGS AND EXPANSION JOINTS

A. The rigid insulation blocks shall be held in place with stainless steel bands, approximately 1/2 inch wide by 0.015 inch thick.

B. After banding, the blocks shall be finished with a trowel coat of insulating cement to filling voids, and troweled to a smooth, neat finish.

C. The installation shall then be covered with an acoustical insulation consisting of a fiberglass fabric weighing 24.6 oz. per sq yd, and coated with a loaded vinyl weighing 83.4 oz. per sq yd.

D. The acoustical insulation shall be Alpha-Sonic Style No. 75.

E. The acoustical insulation shall be covered with a 100-percent fiberglass lagging fabric as indicated.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Provide valve and gate actuators and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility

1. Make the valve or gate manufacturer responsible for the coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Division 16 apply to the Work of this Section.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
05500	Metal Fabrications
09960	High-Performance Coatings
16010	Electrical General Provisions
15205	Common Requirements for Process Valves

1.03 REFERENCES

A. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME BPVC SEC VIII	Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
American Water Works Association (AWWA)	
AWWA C 500	Metal-Seated Gate Valves for Water Supply Service
AWWA C504	Rubber-Seated Butterfly Valves
AWWA C 542	Electric Motor Actuators for Valves and Slide Gates

National Fire Protection Association (NFPA)	
NPFA 70	National Electrical Code

1.04 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals and Section 15205 – Common Requirements of Process Valves.

B. Submit Shop Drawing information for actuators with the valve and gate submittals as a complete package.

C. Submit calculations showing dynamic seating and unseating torques versus the output torque of the actuator.

PART II - PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, provide shut-off and throttling valves and externally actuated valves and gates with manual or power actuators.

B. Provide actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, hand wheels, levers, chains, and extensions, as applicable.

C. Provide actuators with torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering.

D. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves.

E. Identify wires of motor-driven actuators by unique numbers.

F. Manufacturers

1. Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer.

2. Where actuators are furnished by different manufacturers, coordinate the selection to result in the fewest number of manufacturers possible.

G. Materials

1. Provide actuators of current models, of the best commercial quality materials, and liberally sized for the required torque.

2. Provide materials suitable for the environment in which the valve or gate is to be installed.

H. Actuator Mounting and Position Indicators

1. Securely mount actuators by means of brackets or hardware specially designed and sized for this purpose and of ample strength.

2. Cast the word "OPEN" on each valve or actuator, with an arrow indicating the direction to open in the counter-clockwise direction.

3. Equip gear and power actuators with position indicators.

4. Where possible, locate manual actuators between 48 and 60 inches above the floor or the permanent working platform.

I. Standards

1. Unless otherwise indicated and where applicable, provide actuators in accordance with AWWA C 542 - Electric Motor Actuators for Valves and Slide Gates.

J. Functionality

1. Coordinate electric actuators with the power requirements of Division 16 – Electrical.

K. Provide fasteners in accordance with the requirements of Section 05500 – Metal Fabrications.

L. Provide coatings in accordance with the requirements of Section 09960 – High-Performance Coatings.

M. Electromechanical actuators shall not be coated.

2.02 MANUAL ACTUATORS

A. General

1. Unless otherwise indicated, provide valves and gates with manual actuators.

2. Provide valves in sizes up to and including 4 inches with direct-acting lever or hand wheel actuators of the manufacturer's best standard design.

3. Provide valves and gates larger than 4-inch with gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the hand wheel.

4. Provide buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psig, valves 30 inches in diameter and larger, and where indicated, with worm gear actuators, hermetically-sealed water-tight and grease-packed.

5. Valves 6-inch to 24-inch diameter may be provided with traveling-nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves

1. Unless otherwise indicated, provide buried valves with extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys.

2. Where indicated, provide buried valves in cast-iron, concrete, or similar valve boxes with covers of ample size in order to allow operation of the valve actuators.

3. Permanently label the valve box covers as required by the local Utility Company or the Engineer.

4. Provide wrench-nuts in compliance with AWWA C 500 - Metal-Seated Gate Valves for Water Supply Service.

C. Chain Actuator

1. Provide manually-activated valves with the stem located more than 7 feet above the floor or operating level with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains supplied by the valve manufacturer.

2. Construct the wheel and guide from ductile iron, cast iron, or steel.

3. Chains

a. Fabricate the chain from hot-dip galvanized steel or stainless steel, and extend to 5 feet, 6 inches above the operating floor level.

b. Provide an extra strong valve stem on chain-actuated valves in order to allow for the extra weight and chain pull.

c. Provide hooks for chain storage where chains interfere with pedestrian traffic.

D. Floor Boxes

1. Provide hot-dipped galvanized cast iron or steel floor boxes and covers to fit the slab thickness, for operating nuts in or below concrete slabs.

2. For operating nuts in the concrete slab, provide a bronze-bushed cover.

E. Tee Wrenches

1. Furnish buried valves with floor boxes with 2 operating keys or one key per 10 valves, whichever is greater.

2. Size the tee wrenches such that the tee handle will be 2 to 4 feet above ground, and to fit the operating nuts.

F. Manual Worm Gear Actuator

1. Provide an actuator consisting of a single- or double-reduction gear unit contained in a weatherproof cast iron or steel body with cover, and a minimum 12-inch diameter handwheel.

2. Provide the actuator to be capable of a 90-degree rotation and equip the actuator with travel stops capable of limiting the valve opening and closing.

3. Provide the actuator with spur or helical gears and worm gearing.

4. Provide a self-locking gear ratio in order to prevent "back-driving."

5. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

6. Construct the worm gear shaft and the hand wheel shaft from 17-4 PH or similar stainless steel.

7. Accurately cut gearing with hobbing machines.

8. Use ball or roller bearings throughout.

9. Provide the output shaft end with a spline in order to allow adjustable alignment.

10. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator.

11. Design gearing for a 100 percent overload.

12. The entire gear assembly shall be sealed weatherproof

G. Design and rate buried gear actuators for buried service, provide with a stainless-steel input shaft, and double-seal on shaft and top cap.

H. Traveling-Nut Actuator

1. Provide the actuator with a traveling-nut and screw (Scotch yoke), contained in a weatherproof cast iron or steel housing with a spur gear and a minimum 12-inch diameter hand wheel.

2. The screw shall run in 2 end bearings and provide a self-locking actuator in order to maintain the valve position under any flow condition.

3. Construct the screw and gear from hardened alloy steel or stainless steel, and the construct the nut and bushings from alloy bronze.

4. The bearings and gear shall be grease-lubricated by means of nipples.

5. Design gearing for a 100 percent overload.

2.03 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements

a. Where electric motor actuators are indicated, attach an electric motor-actuated valve control unit to the actuating mechanism housing by means of a flanged motor adapter piece.

2. Gearing

a. Provide the motor actuator with the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly.

b. Provide a single- or double-reduction unit, consisting of spur or helical gears and worm gearing.

c. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

d. Accurately cut gearing with hobbing machines.

e. Power gearing shall be grease- or oil-lubricated in a sealed housing.

f. Use ball or roller bearings throughout.

g. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.

3. Starting Device

a. Except for modulating valves, design the unit such that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve.

b. The device shall allow free movement at the stem nut before imparting the hammer blow.

c. The actuator motor shall attain full speed before the stem load is encountered.

4. Switches

a. Electronic-Type Switches

1) Limit switches or valve position shall be sensed by a 15-bit, optical, absolute position encoder.

2) The open and closed positions shall be stored in a permanent, non-volatile memory.

3) The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery.

4) Provide an electronic torque sensor.

5) Provide an adjustable torque limit, from 40 to 100 percent of rating in one-percent increments.

6) The motor shall be de-energized if the torque limit is exceeded.

7) Provide a boost function in order to prevent torque-trip during initial valve unseating, and a "jammed valve" protection feature with automatic retry sequence in order to de-energize the motor if no movement occurs.

8) Provide valve actuators with electronic type switches as manufactured by Limitorque, EIM or Auma Actuators, Inc.

b. The actuator shall be wired in accordance with the schematic diagram.

c. Connect wiring for external connections to marked terminals.

d. Provide one 1-inch and one 1-1/4-inch conduit connection in the enclosing case.

e. Mount a calibration tag near each switch, correlating the dial setting to the unit output torque.

f. Switches shall not be subject to breakage or slippages due to over-travel.

g. Do not use traveling-nuts, cams, or microswitch tripping mechanisms.

h. Provide limit switches of the heavy-duty, open contact type, with rotary wiping action.

5. Handwheel Operation

a. Provide a permanently attached handwheel for emergency manual operation.

b. The handwheel shall not rotate during electrical operation.

c. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb.

d. Cast or permanently affix an arrow and either the word "OPEN" or "CLOSE" on the handwheel in order to indicate the appropriate direction to turn the handwheel.

e. Provide a clutch lever to put the actuator into handwheel operation.

f. Provide chain activator handwheels for valves with electric motor actuators having stems more than 7 feet above the floor.

g. Provide the clutch lever with a cable secured to the chain in order to allow disengagement for manual operation.

6. Motor

a. Provide a motor of the totally enclosed, non-ventilated, high-starting torque, low-starting current type, for full-voltage starting.

b. The motor shall be suitable for operation on 480 volt, 3 phase, 60 Hz current, with Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards.

c. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C, when operating continuously for 15 minutes under full-rated load.

d. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full-rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop out.

e. Provide bearings of the ball type and provide thrust bearings where necessary.

f. Provide the bearings with suitable seals in order to confine the lubricant and to prevent the entrance of dirt and dust.

g. Provide watertight motor conduit connections.

h. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement.

i. Provide two Class B thermal contacts or solid-state thermistors embedded within the motor windings in order to protect against over-temperature damage.

j. Provide the motor with a space heater suitable for operation on a 120-volt, single-phase, 60-Hz circuit, unless the entire actuator is of a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.

k. Provide each electric motor actuator with a local disconnect switch or circuit breaker in order to isolate power from the motor and controller during maintenance activities.

7. Open/Close Operating Speed

a. Unless otherwise indicated, electric actuators for isolation valves shall provide a full-close-to-full-open or full-open-to-full-close operating time range from 30 to 55 seconds.

b. Unless otherwise indicated, electric actuators for gates shall provide a normal open/ close operating speed of 12 inches per minute.

8. Elevated Valves

a. For valves with electric motor actuators where the valve centerline is located at a height greater than 6 feet above the floor, provide a remote actuator control station at a location no higher than 4 feet above the floor.

b. Provide conduit and wiring between the actuator controls and the valve actuator for these applications.

c. Wall-mount the actuator controls beneath the valve at a location approved by the Engineer.

B. Electric Motor Actuators (AC Reversing Control Type)

1. General

    a. Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with OPEN/CLOSE and LOCAL/AUTO /REMOTE selector switches.

2. Actuator Appurtenances

    a. Provide the actuator for each valve with: OPEN and CLOSE status lights; OPEN, CLOSE, and LOCKOUT/STOP push buttons; and other indicated devices.

3. Starter

    a. Provide a suitably sized amperage-rated reversing starter with its coils rated for operation on 480-volt, 3-phase, 60-Hz current.

    b. Provide a control power transformer in order to provide a 120-volt source, unless otherwise indicated.

    c. Equip the starter with 3 overload relays of the automatic reset type and wire the control circuit as indicated.

    d. The integral weatherproof compartment shall contain a suitably sized 120-volt AC, single-phase, 60-Hz space heater in order to prevent moisture condensation on electrical components.

    e. Provide a local power disconnect switch and a close-coupled, padlockable switch with each actuator.

4. Local Control Station

    a. Provide each actuator with a local control station along with the valve actuator assembly.

    b. The station shall include OPEN, CLOSE, and STOP push buttons, and a LOCAL/REMOTE selector switch.

    c. Where indicated on the Instrumentation Drawings, provide a 2-wire control system as indicated above.

    d. The local control station and local power disconnect may be provided as an integral part of the actuator, or as otherwise indicated or required in order to permit operation by a person at floor elevation and within sight of the valve actuator.

5. Electric Motor Actuators (AC Reversing Control Type) Manufacturer

    a. Auma Actuators, Inc.

    b. EIM

C. Electric Motor Actuators (AC Modulating Control Type)

1. General

   a. Where indicated, modulating electric motor actuators shall be of the AC-modulating type, provided complete with a local control station with power disconnect switch or circuit breaker, LOCAL/REMOTE switch, non-latching OPEN/CLOSE pushbuttons, and OPEN/CLOSE status lights

2. Actuator Appurtenances

   a. Provide the actuator for each valve with a padlock able disconnect switch; OPEN and CLOSED status lights; OPEN, CLOSE, and LOCKOUT/STOP pushbuttons; a LOCAL/REMOTE selector switch; and other indicated devices.

3. Control Module

   a. Provide a control module of the electronic solid-state AC type, with control outputs for positioning the valve via 4 to 20 ma input signals.

4. Starter

   a. The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes.

   b. The solid-state starter and control module shall be rated for continuous modulating applications.

   c. The power supply shall be 480-volt, 3-phase, 60-Hz.

   d. Provide a disconnect switch with each actuator.

5. Construction

   a. The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random-access memory for storage of calibration parameters, and push-button calibration elements for field setup.

   b. Potentiometer adjustments shall contain a PID control function internally.

   c. The controller shall contain as a standard feature a loss-of-command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 to 20 mA

   d. Where indicated on the Instrumentation Drawings, provide a 2-wire control system as indicated above.

e. The system shall allow the control of the open, close, or percent open function when the LOCAL/REMOTE switch is in the REMOTE position.

f. Provide each actuator with a frequency shut-down system, which when pre-programmed shall function as directed upon receipt of an ESD signal.

6. Electric Motor Actuators (AC Modulating Control Type) Manufacturer

a. EIM

b. Auma Actuators, Inc.

D. Electric Motor Actuators (DC Modulating Control Type)

1. Equipment Requirements

a. Where indicated, provide electric motor actuators of the DC modulating control type, and attach to the actuating mechanism housing.

2. Actuator Assembly

a. The assembly shall include a DC motor, reduction gearing, a control unit, limit-switches, and required accessories, within one enclosure.

3. Control Unit

a. Provide an electric motor-operated control unit suited for an input power supply of 90 to 140 volts, 60 Hz AC, and to operate satisfactorily when input power is within those limits.

b. Power will be supplied at 120 volts, single-phase, 60 Hz AC.

c. Provide a control unit suited to receive an input set-point signal from an external source of 4 to 20 ma DC with properly selected calibrating resistor.

4. Control Panel

a. Provide each actuator with a separate local control panel for attachment to the valve actuator assembly.

b. Provide the panel with an OPEN/CLOSE/AUTO/HOLD selector switch and suitable for indoor or outdoor installation, as required.

5. Electric Motor Actuators (DC Modulating Control Type) Manufacturer

a. EIM, Futronic-III

b. Limitorque Corp., Modutronic-10

PART III - EXECUTION

3.01 SERVICES OF MANUFACTURER

A. Field Adjustments

1. The adjustment of actuator controls and limit switches in the field for the required function shall be performed by field representatives of the manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators.

3.02 INSTALLATION

A. Install valve and gate actuators and accessories in accordance with the requirements of Section 15205 – Common Requirements for Process Valves.

B. Locate the actuators to be readily accessible for operation and maintenance without obstructing walkways.

C. Do not mount actuators where shock or vibrations will impair their operation, and do not attach the support systems to handrails, process piping, or mechanical equipment.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The Contractor shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01600	Products, Materials, Equipment and Substitutions
01730	Operation and Maintenance Data
15201	Actuators for Process Valves and Gates
15205	Common Requirements for Process Valves

1.03 REFERENCES

A. Reference Standards

American National Standards Institute (ANSI)	
ANSI B 16.1	Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
American Petroleum Institute (API)	
API 598	Valve Inspection and Testing
API 609	Butterfly Valves: Double-flanged, Lug- and Wafer-type, and Butt-welding Ends
American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASME B31.3	Process Piping
American Water Works Association (AWWA)	
AWWA C504	Standard for Rubber-Seated Butterfly Valves
AWWA C541	Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
ASTM International (ASTM)	
ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 276	Standard Specification for Stainless Steel Bars

	and Shapes
ASTM A 536	Standard Specification for Ductile Iron Castings

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 15205 – Common Requirements for Process Valves.

B. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.

2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.

3. Dynamic seating and unseating torque for motor actuated valves.

4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.

5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

C. Operation and Maintenance Manuals:

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

1.05 WARRANTY

A. Provide Warranty as specified in Section 15205 – Common Requirements for Process Valves.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with Section 01600 – Products, Materials, Equipment and Substitutions.

B. Protect valves and factory-applied coatings from damage during handling and installation. Repair any damaged areas in accordance with manufacturer’s recommendations.

PART II - PRODUCTS

2.01 BUTTERFLY VALVES FOR AIR SERVICE

A. General: Butterfly valves for air systems shall be specifically designed for this service and meet or exceed the design, strength, performance, and testing standards of AWWA C504. Valves shall be suitable for pressures from vacuum to 125 psi and temperatures from minus 40 degrees F to 250 degrees F.

B. Body: The valve body shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B, with either wafer, lug, or flanged design as indicated, drilled to ANSI B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, Class 125.

C. Disc: The disc shall be of ductile iron conforming to ASTM A 536 - Ductile Iron Castings or cast-iron conforming to ASTM A 48 - Gray Iron Castings, or ASTM A 126 with an edge of monel, Type 316 stainless steel, or nickel. The disc shall be designed with the air-profile or other suitable shape. Sprayed or plated disc edges are not acceptable.

D. Seat: The elastomer seat shall be in the body. It shall be field-replaceable without special tools. Except for use with petroleum-based fluids, the seat material shall be Ethylene-Propylene-Diene Monomer (EPDM), or other suitable material, to provide a tight shut-off at the temperatures above.

E. Shaft: The valve shaft shall be of Type 316 or 304 stainless steel with sufficient strength to allow for the increased torque for air service.

F. Bearings: Shaft bearings shall be of the self-lubricating corrosion-resistant sleeve type.

G. Packing: The packing shall be of the adjustable or self-adjustable (O-ring) type, suitable for the temperature and service conditions.

H. Manual Actuators: Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches and larger.

I. Worm Gear Actuators: Valves 30-inches and larger shall be equipped with worm-gear actuators, lubricated, and sealed to prevent entry of dirt or water into the housing.

J. Electric Actuators: Electric actuators shall meet the requirements of AWWA C541 and be in accordance with Section 15201 – Actuators for Process Valves and Gates. Electric actuators in open/close service shall be rated to produce output torque of at least 1.5 times the required valve maximum seating or maximum dynamic torque whichever is greater. For valves in modulating service with dynamic torque exceeding the seating

torque, the rated output torque of the actuator shall be twice the dynamic torque required by the valve. Actuator rated torque is defined as pullout torque rated at 10 percent below the rated voltage of the motor. The torque switch shall be field set at no greater than 60 percent and 50 percent of the maximum actuator rated torque for open/close service and modulating service, respectively. After plant startup, the manufacturer shall prepare a certification including a torque curve to demonstrate that the torque requirements have been met.

K. Manufacturers

1. DeZURIK Water Controls Corporation

2. Henry Pratt Company

3. Kennedy Valve

PART III - EXECUTION

3.01 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 15205 – Common Requirements for Process Valves.

3.02 TESTING

A. Valves shall be tested in accordance with the testing requirements specified in Section 15205 – Common Requirements for Process Valves.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01600	Products, Materials, Equipment and Substitutions
01730	Operation and Maintenance Data
15205	Common Requirements for Process Valves

1.03 REFERENCES

A. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B1.20.1	Pipe Threads, General Purpose (inch)
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
American Water Works Association (AWWA)	
AWWA C508	Swing-Check Valves for Waterworks Service
ASTM International (ASTM)	
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B16	Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines
ASTM B148	Aluminum-Bronze Castings
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM B763	Copper Alloy Sand Castings for Valve Application

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 15205 – Common Requirements for Process Valves.

B. Operation and Maintenance Manuals:

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

1.05 WARRANTY

A. Provide Warranty as specified in Section 15205 – Common Requirements for Process Valves.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with Section 01600 – Products, Materials, Equipment and Substitutions.

B. Protect valves and factory-applied coatings from damage during handling and installation. Repair any damaged areas in accordance with manufacturer's recommendations.

PART II - PRODUCTS

2.01 SWING CHECK VALVES (3-INCHES AND LARGER)

A. General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

B. Body: The valve body and cover shall be of cast iron conforming to ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or be mechanical joint ends, as indicated.

C. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B584 - Copper Alloy Sand Castings for General Applications.

D. Seat and Rings: The valve seat and rings shall be of bronze conforming to ASTM B584 or ASTM B148 - Aluminum-Bronze Castings or of Buna-N.

E. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

F. Limit Switches: Limit switches shall be provided on check valve swing arms where indicated. Switches shall be roller lever rotary actuated type, with contacts rated for 10 amp at 120 VAC. Switches shall be located to actuate when the check valve is fully closed and deactivate when the valve begins to open. Switches shall be Honeywell Microswitch Model 1LS1, Square D 9007 C.

G. Manufacturers

1. DeZurik/APCO

2. Kennedy Valve

3. Mueller Company

4. Stockham Valves and Fittings

5. GA Industries

2.02 SWING CHECK VALVES (2-1/2 INCHES AND SMALLER)

A. General: Swing check valves for steam, water, oil, or gas in sizes 2-1/2 inches and smaller shall be suitable for a steam pressure of 150 psi and a cold-water pressure of 300 psi. Units shall have screwed ends unless otherwise indicated, and screwed caps.

B. Body: The valve body and cap shall be of bronze conforming to ASTM B763 - Copper Alloy Sand Castings for Valve Application, or ASTM B584 with threaded ends conforming to ASME B1.20.1 - Pipe Threads, General Purpose (inch).

C. Disc: Valves for steam service shall have bronze or brass discs conforming to ASTM B16 - Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.

D. Hinge Pin: The hinge pins shall be bronze or stainless steel.

E. Manufacturers

1. Crane Company

2. Milwaukee Valve

3. Stockham Valves and Fittings

4. Wm. Powell Company

PART III - EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 15205 – Common Requirements for Process Valves.

3.02 TESTING

A. Valves shall be tested in accordance with the testing requirements specified in Section 15205 – Common Requirements for Process Valves.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01600	Products, Materials, Equipment and Substitutions
01730	Operation and Maintenance Data
15205	Common Requirements for Process Valves
15201	Actuators for Process Valves and Gates

1.03 REFERENCES

A. Reference Standards

American National Standards Institute (ANSI)	
ANSI B 16.5	Pipe Flanges and Flanged Fittings

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 15205 – Common Requirements for Process Valves.

B. Operation and Maintenance Manuals:

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

1.05 WARRANTY

A. Provide Warranty as specified in Section 15205 – Common Requirements for Process Valves.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with Section 01600 – Products, Materials, Equipment and Substitutions.

B. Protect valves and factory-applied coatings from damage during handling and installation. Repair any damaged areas in accordance with manufacturer's recommendations.

PART II - PRODUCTS

2.01 METAL BALL VALVES (4-INCHES AND SMALLER)

A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have manual actuators in accordance with Section 15201 – Actuators for Process Valves and Gates.

B. Body: Ball valves up to and including 1-1/2 inches in size shall have bronze or carbon steel 2- or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 4-inches in size shall have bronze or carbon steel 2- or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

C. Balls: The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

D. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.

E. Seats: The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

F. Manufacturers

1. Conbraco Industries, Inc. (Apollo)
2. ITT Engineered Valves
3. Neles-Jamesbury, Inc.
4. Watts Regulator
5. Worcester Controls

2.02 STAINLESS STEEL BALL VALVES (2-1/2 INCH AND SMALLER)

A. General: Stainless steel ball valves for air lift pumps, instrument air and other applications noted on the Contract Drawings shall be made of Type 316 stainless steel. Valves shall have manual actuators in accordance with Section 15201 - Actuators for Process Valves and Gates, unless otherwise indicated.

B. Construction: Valves shall be two-piece stainless steel full port; solid ball construction with bottom loading stems, and adjustable packing with manual locking lever actuator. Body shall be ASTM A276, Type 316 or ASTM A351 Grade CF8M stainless steel, Type 316 stainless steel ball and stem, seats and seals shall be reinforced PTFE, FNPT ends, 2000 psig rated at 200 Deg F.

C. Manufacturers

1. Jamesbury

2. KF Contromatics

PART III - EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with Section 15205 – Common Requirements for Process Valves.

3.02 TESTING

A. Valves shall be tested in accordance with the testing requirements specified in Section 15205 – Common Requirements for Process Valves.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Provide valves, actuators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated.

C. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls, as indicated.

D. Support

1. Where a valve is to be supported by means other than the piping to which it is attached, obtain from the valve manufacturer a design for its support and foundation that satisfies the criteria in Section 11000 – Equipment General.

2. Submit the support design, including drawings and calculations sealed by an engineer, with the Shop Drawings.

E. Unit Responsibility

1. The CONTRACTOR shall assign a single manufacturer to be responsible for the supply, coordination of design, assembly, testing, and furnishing of each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve Section.

F. Single Manufacturer

1. Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
01730	Operation and Maintenance Data
05500	Metal Fabrications
09960	High-Performance Coatings
11000	Equipment General
15001	Piping General

15005	Piping Identification
15201	Actuators for Process Valves and Gates
16220	Motors

1.03 REFERENCES

A. Reference Standards

American National Standards Institute (ANSI)	
American Water Works Association (AWWA)	
ASTM International (ASTM)	
ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 351	Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A 395	Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 515	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 536	Standard Specification for Ductile Iron Castings
ASTM B 62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 584	Standard Specification for Copper Alloy Sand Castings for General Applications
Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)	
MSS SP-25	Standard Marking Systems for Valves, Fittings, Flanges, and Unions
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects

1.04 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals.

B. Furnish the following information on Shop Drawings:

1. valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.

2. complete information on the valve actuator, hydraulic power units (HPU), pneumatic air supply system including size, manufacturer, model number, limit switches, and mounting.

3. cavitation limits for control valves.

4. assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. data for electric motor-actuated valves.

6. complete wiring diagrams and control system schematics; and,

7. A valve-labeling schedule, listing the valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Furnish a technical manual containing the required information for each valve, as indicated.

D. Furnish a spare parts list, containing the required information for each valve assembly, as indicated.

E. Factory Test Data

1. Where indicated, submit signed, dated, and certified factory test data for each valve requiring certification, before shipping the valve.

2. Furnish a certification of quality and test results for factory-applied coatings.

F. Field Test Data

1. Submit signed, dated, and certified field test data for each valve.

1.05 WARRANTY

A. The manufacturer shall warrant that the equipment supplied to be free of defects in material and workmanship for a period of one (1) year from the date of substantial completion.

PART II - PRODUCTS

2.01 PRODUCTS

A. General

1. Provide valves and gates of new and current manufacture.

2. Provide valves 6-inch and larger with actuators with position indicators.

3. Unless otherwise indicated, provide valve actuators in accordance with Section 15201 – Actuators for Process Valves and Gates.

B. Protective Coating

1. Coat the exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 2-inch and larger in accordance with the requirements of Section 09960 – High-Performance Coatings.

2. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with the indicated requirements.

3. Do not coat the machined flange faces of valves except where such flanges are not adjoining a mating flange as shown in the Contract Documents. Apply rust inhibitor coating on machined surfaces of the flange prior to shipment.

C. Valve Labeling

1. Except when such requirement is waived by the Engineer in writing, provide a label on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves.

2. Furnish a label composed of 1/16-inch plastic or stainless steel, a minimum of 2 inches by 4 inches in size, as indicated in Section 15005 – Piping Identification, and permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.

D. Valve Testing

1. As a minimum, unless otherwise indicated or recommended by the reference standards, test valves 3 inches in diameter and smaller in accordance with the manufacturer's standard procedure.

2. Factory-test valves 4 inches in diameter and larger as follows:

    a. Hydrostatic Testing

        1) Subject valve bodies to an internal hydrostatic pressure equivalent to twice the water-rated pressure of the valve.

        2) Metallic valves rating pressures shall be based at 100 degrees F.

        3) Plastic valves rating pressures shall be based at 73 degrees F, or at a higher temperature according to material type.

        4) During the hydrostatic test, there shall be no visible leakage through the valve body, end joints, or shaft seals, nor shall parts of the valve be permanently deformed.

        5) Allow test duration of at least 10 minutes, in order to allow visual examination for leakage.

    b. Seat Testing

        1) Test the valves for leaks in the closed position, with the pressure differential across the seat equal to the water rated pressure of the valve.

        2) Provide test duration of at least 10 minutes, in order to allow visual examination for leakage.

        3) The leakage rate shall be the more stringent of the following:

            a) As recommended by the reference standard for that type of valve; or

            b) Leakage past the closed valve not to exceed one fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

    c. Performance Testing

        1) Shop-operate the valves from the fully-closed to the fully-open position and reverse under no-flow conditions in order to demonstrate that the valve assembly operates properly.

E. Certification

1. Prior to shipment of valves with sizes larger than 4-inches in diameter, submit certified, notarized copies of the factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

F. Valve Markings

1. Permanently mark valve bodies in accordance with MSS SP-25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.02 MATERIALS

A. General

1. Provide materials suitable for the intended application.

2. Provide materials in contact with potable water listed as compliant with NSF/ANSI 61.

3. Ensure that materials not indicated are of high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

4. Unless otherwise indicated, provide valve and actuator bodies conforming to the following requirements:

   a. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings

   b. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

   c. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

   d. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications. Bronze materials in contact with potable water service shall be free of lead content meeting the Lead Reduction Act.

   e. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel

   f. PVC: Polyvinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454

   g. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447

h. NSF/ANSI 61: Materials shall be listed for use in contact with potable water.

i. Elastomeric materials used for seat, seals and O-rings shall be compatible with temperature, pressures and fluid or gas service.

1) Elastomeric materials for water with chloramines shall be Teflon or Viton-A.

2) Elastomeric materials for water with dissolved ozone residual shall be Teflon suitable for ozone service.

3) Elastomeric materials for oxygen (LOX or GOX) shall be Teflon specially manufactured and packaged suitable for oxygen service.

2.03 VALVE CONSTRUCTION

A. Bodies

1. Provide valve bodies that are cast, molded (in the case of plastic valves), forged, or welded, of the materials indicated, and with smooth interior passages.

2. Provide wall thicknesses uniform and in agreement with the applicable standards for each type of valve, without casting defects, pinholes, and other defects that could weaken the body.

3. Perform welds on welded bodies by certified welders and ground welds smooth.

4. Provide valve ends as indicated and rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections

1. Unless otherwise indicated, valves 2-1/2 inches in diameter and smaller may be provided with threaded end connections.

2. Unless otherwise indicated, provide valves 3 inches in diameter and larger with flanged end connections.

3. Flanges, bolts and gaskets shall be as specified in Section 15001 - Piping General.

C. Bonnets

1. Connect valve bonnets to the body by clamping, screwing, or flanging.

2. Provide bonnets of the same material, temperature, and pressure rating as the body.

3. Make provisions for the stem seal with the necessary glands, packing nuts, and yokes.

D. Stems

1. Provide valve stems of the materials indicated, or, if not indicated, of the best commercially-available material for the specific service, with adjustable stem packing, O-rings, chevron V-type packing, or other suitable seal. Bronze materials in contact with potable water shall be NSF 61 approved and free of lead. Elastomeric materials shall be compatible with fluid service.

2. Where dezincification is not a problem, bronze conforming to ASTM B 584 may be used, except that the zinc content shall not exceed 16 percent.

E. Stem Guides

1. Provide stem guides spaced with an L/R ratio not to exceed 200:1. Submit calculations for L/R ratios and guide spacing to the Engineer for review.

2. Stem guides shall have slotted holes and shall be adjustable in two directions.

3. Construct submerged stem guides from Type 316 stainless steel.

F. Internal Parts

1. Provide internal parts and valve trim as indicated for each individual valve.

2. Where not indicated, construct valve trim from Type 316 stainless steel or other material best-suited for the intended service.

G. Nuts and Bolts

1. Unless otherwise indicated, provide nuts and bolts on valve flanges and supports in accordance with the requirements of Section 05500 – Metal Fabrications and Section 15001 – Piping General.

2.04 EXTENSION SHAFT STEM

A. Valves mounted in dry areas with gearbox attached to the valve and with remote actuator shall be supplied with an extension shaft stem with universal joint attached to the gear and actuator. All components shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, shaft stem and universal joints shall be made of carbon steel with epoxy coating suitable for the fluid service. Each valve, shaft stem, floor stand and actuator shall be pre-assembled and

"matched marked" in the manufacturer's shop to ensure proper fit when assembled in field.

2.05 VALVE ACTUATORS

A. Valve actuators shall be as indicated and as specified in Section 15201 – Actuators for Process Valves and Gates.

2.06 VALVE ACCESSORIES

A. Provide valves complete with the accessories required to provide a functional system.

2.07 SPARE PARTS

A. Furnish the required spare parts, suitably packaged and labeled with the valve name, location, and identification number.

B. Furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve.

C. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.08 MANUFACTURERS

A. Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the indicated valves.

PART III - EXECUTION

3.01 VALVE INSTALLATION AND TRIAL OPERATION

A. General

1. Install valves, actuating units, stem extensions, valve boxes, and accessories in accordance with the manufacturer's written instructions and as indicated.

2. Adequately brace gates in order to prevent warpage and bending under the intended use.

3. Firmly support valves in order to avoid undue stresses on the pipe.

B. Access

1. Install valves in a manner to provide easy access for actuation, removal, and maintenance, and to avoid interference between valve actuators and structural members, handrails, and other equipment.

C. Valve Accessories

1. Where combinations of valves, sensors, switches, and controls are indicated, properly assemble, and install such items such that systems are compatible and operating properly.

2. Clearly note the relationship between interrelated items on Shop Drawing submittals.

D. Trial Operation

1. After installation, schedule trial operation witnessed by the Engineer and the Owner.

2. All valves shall be cleaned thoroughly of all foreign materials and final adjustments made. The valves shall then be operated through one complete cycle from a fully closed position to a fully open position and back to a fully closed position to verify that the assembly is functional.

3. For control valves that operate in multiple operating scenarios, the Contractor shall simulate all operational scenarios including the hydraulic power units, pilot control system or pneumatic air supply system to demonstrate compliance to the specifications.

4. A field leakage test meeting the maximum allowable specified requirement shall be conducted.

5. Test certificate shall be signed by the valve manufacturer and the Contractor and shall be submitted to the Engineer.

3.02 FIELD QUALITY CONTROL

A. Coordinate inspection of all valves by manufacturer's representative, confirm valve orientation is correct, and instruct Owner on their operation and maintenance.

3.03 VALVE SCHEDULE

A. The following Valve Schedule shall apply to all valves 4 inches and larger, and all actuated valves. This Valve Schedule does not include vendor-supplied valves. Contractor shall provide all valves as required by the Contract Drawings. This Valve Schedule does not include all number and types of valves required for the Project.

B. The following Valve Schedule Notes shall apply where indicated:

1. 100% (full) port and glass-lined

2. Handwheel actuator mounted on valve stem extension to operator floor

C. Abbreviations relating to Actuator Type:

1. CW = Chainwheel
2. HW = Handwheel
3. L = Lever

Valve Tag	Drawing Number	Valve Type	Valve Size, in	Location	Fluid Service	Actuator Type	Actuator Service	Controls	Notes
LSPU1-CV-01	03-I-601	CHECK	6	BPLS EFFLUENT LIFT STATION VALVE VAULT	TF	N/A	N/A	N/A	
LSPU2-CV-01	03-I-601	CHECK	6	BPLS EFFLUENT LIFT STATION VALVE VAULT	TF	N/A	N/A	N/A	
LSPU3-CV-01	03-I-601	CHECK	6	BPLS EFFLUENT LIFT STATION VALVE VAULT	TF	N/A	N/A	N/A	
LSPU1-PV-01	03-I-601	PLUG	6	BPLS EFFLUENT LIFT STATION VALVE VAULT	TF	HW	N/A	N/A	(1)
LSPU2-PV-01	03-I-601	PLUG	6	BPLS EFFLUENT LIFT STATION VALVE VAULT	TF	HW	N/A	N/A	(1)
LSPU3-PV-01	03-I-601	PLUG	6	BPLS EFFLUENT LIFT STATION VALVE VAULT	TF	HW	N/A	N/A	(1)
LSPI1-PV-01	03-I-601	PLUG	8	ARF BYPASS VALVE VAULT	TF	HW	N/A	N/A	(1)
LSPI1-PV-02	03-I-601	PLUG	10	ARF BYPASS VALVE VAULT	TF	HW	N/A	N/A	
LSPI1-PV-03	03-I-601	PLUG	10	ARF BYPASS VALVE VAULT	TF	HW	N/A	N/A	
LSPI3-PV-01	03-I-601	PLUG	8	ARF BYPASS VALVE VAULT	ARE	HW	N/A	N/A	
LSPI1-PV-04	04-I-601	PLUG	8	FLOW METER STATION	TF	HW	N/A	N/A	(1)
LSPI1-PV-05	04-I-601	PLUG	8	FLOW METER STATION	TF	HW	N/A	N/A	(1)
LSPI1-PV-06	04-I-601	PLUG	8	FLOW METER STATION	TF	HW	N/A	N/A	(1)
LSPI1-PV-07	04-I-601	PLUG	8	EQ BASIN	TF	CW	N/A	N/A	(1)
LSPI1-PV-08	04-I-601	PLUG	8	EQ BASIN BYPASS	TF	CW	N/A	N/A	(1)
LSPU4-PV-01	04-I-602	PLUG	6	EQ TRANSFER LIFT STATION	TF	HW	N/A	N/A	(1)
LSPU5-PV-01	04-I-602	PLUG	6	EQ TRANSFER LIFT STATION	TF	HW	N/A	N/A	(1)
LSPU6-PV-01	04-I-602	PLUG	6	EQ TRANSFER LIFT STATION	TF	HW	N/A	N/A	(1)
LSPU4-PV-02	04-I-602	PLUG	6	EQ TRANSFER LIFT STATION	TF	CW	N/A	N/A	(1)
LSPU5-PV-02	04-I-602	PLUG	6	EQ TRANSFER LIFT STATION	TF	CW	N/A	N/A	(1)
LSPU6-PV-02	04-I-602	PLUG	6	EQ TRANSFER LIFT STATION	TF	CW	N/A	N/A	(1)
LSPU4-CV-01	04-I-602	CHECK	6	EQ TRANSFER LIFT STATION	TF	N/A	N/A	N/A	
LSPU5-CV-01	04-I-602	CHECK	6	EQ TRANSFER LIFT STATION	TF	N/A	N/A	N/A	

Valve Tag	Drawing Number	Valve Type	Valve Size, in	Location	Fluid Service	Actuator Type	Actuator Service	Controls	Notes
LSPU6-CV-01	04-I-602	CHECK	6	EQ TRANSFER LIFT STATION	TF	N/A	N/A	N/A	
LSPI2-PV-01	04-I-602	PLUG	8	EQ BASIN	TF	CW	N/A	N/A	(1)
LSPI2-PV-02	04-I-602	PLUG	8	EQ BASIN DRAIN	TF	HW	N/A	N/A	
NH3R1-PV-01	04-I-604	PLUG	6	ARF EFFLUENT CHANNEL	TF	HW	N/A	N/A	(2)
NH3R1-PV-02	04-I-604	PLUG	6	ARF EFFLUENT CHANNEL	ARE	HW	N/A	N/A	(2)
NH3R2-PV-01	04-I-605	PLUG	6	ARF EFFLUENT CHANNEL	TF	HW	N/A	N/A	(2)
NH3R2-PV-02	04-I-605	PLUG	6	ARF EFFLUENT CHANNEL	ARE	HW	N/A	N/A	(2)
LSPU7-PV-01	04-I-607	PLUG	6	ARF EFFLUENT LIFT STATION	ARE	HW	N/A	N/A	(2)
LSPU7-PV-02	04-I-607	PLUG	6	ARF EFFLUENT LIFT STATION	ARE	HW	N/A	N/A	
LSPU8-PV-01	04-I-607	PLUG	6	ARF EFFLUENT LIFT STATION	ARE	HW	N/A	N/A	
LSPU8-PV-02	04-I-607	PLUG	6	ARF EFFLUENT LIFT STATION	ARE	HW	N/A	N/A	
LSPU9-PV-01	04-I-607	PLUG	6	ARF EFFLUENT LIFT STATION	ARE	CW	N/A	N/A	
LSPU9-PV-02	04-I-607	PLUG	6	ARF EFFLUENT LIFT STATION	ARE	CW	N/A	N/A	
EFPU3-PV-02	04-I-607	PLUG	6	ARF EFFLUENT LIFT STATION	ARE	CW	N/A	N/A	
LSPU7-CV-01	04-I-607	CHECK	6	ARF EFFLUENT LIFT STATION	ARE	N/A	N/A	N/A	
LSPU8-CV-01	04-I-607	CHECK	6	ARF EFFLUENT LIFT STATION	ARE	N/A	N/A	N/A	
LSPU9-CV-01	04-I-607	CHECK	6	ARF EFFLUENT LIFT STATION	ARE	N/A	N/A	N/A	

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. Plug valves shall have undergone a proof-of-design test to demonstrate that the valve components operate at the service flow, pressure, temperature, and fluid conditions, free from binding, excessive noise, and premature failures. Proof-of-design test results shall be available to the Engineer on request. The proof-of-design test shall be conducted in accordance with the applicable provisions of AWWA C517- Resilient-Seated Cast-Iron Eccentric Plug Valves.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01600	Products, Materials, Equipment and Substitutions
01730	Operation and Maintenance Data
15205	Common Requirements for Process Valves
15201	Actuators for Process Valves and Gates

1.03 REFERENCES

A. Reference Standards

American Water Works Association (AWWA)	
AWWA C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
ASTM International (ASTM)	
ASTM A 126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 536	Ductile Iron Castings

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 15205 – Common Requirements for Process Valves.

B. Operation and Maintenance Manuals:

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

1.05 WARRANTY

A. Provide Warranty as specified in Section 15205 – Common Requirements for Process Valves.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with Section 01600 – Products, Materials, Equipment and Substitutions.

B. Protect valves and factory-applied coatings from damage during handling and installation. Repair any damaged areas in accordance with manufacturer's recommendations.

PART II - PRODUCTS

2.01 ECCENTRIC PLUG VALVES (1/2-INCH TO 72 INCHES)

A. Construction: Eccentric plug valves shall be of the non-lubricated, eccentric plug design with cast iron bodies conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with ANSI 125 lb. flanged ends for valves 3-inches and larger, and screwed or flanged ends for smaller sizes. The plugs and shafts shall be of cast iron or ductile iron conforming to ASTM A 536 - Ductile Iron Castings, and the plugs shall be lined with a resilient coating, best suited for the specific service. The body shall be lined with a suitable elastomer, where required for a special service, or it shall be epoxy-lined in accordance with Section 09960 – High-Performance Coatings. The seats shall be of nickel or stainless steel welded to the body. Top and bottom shaft bearings shall be of permanently lubricated stainless steel or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals. Valves up to and including 20-inches in size shall have an unobstructed port area of not less than 80 percent of full pipe area. Valves 24-inches and larger shall have an unobstructed port area of 100% of pipe area. Eccentric plug valves shall have a pressure rating of not less than 150 psi WOG, for bubble-tight shut-off in the standard flow direction, and 25 psi WOG in the reverse flow direction. When equipped with worm gear actuator, the pressure rating shall be 150 psi WOG in both directions. The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing.

B. Actuators: Unless otherwise indicated, eccentric plug valves 3-inches and smaller shall have operating levers; larger valves shall have worm-gear actuators. Valve actuators shall be in accordance with Section 15201 – Actuators for Process Valves and Gates.

C. Internal Glass Lining: Where indicated in the Valve Schedule and on the Contract Documents valves are to be provided with glass lining.

D. Manufacturers

1. DeZurik Corporation
2. Clow Valve Company
3. Pratt Valve
4. Victaulic

PART III - EXECUTION

3.01 INSTALLATION

A. Plug valves shall be installed in strict accordance with the manufacturer's published recommendations and the applicable provisions of Section 15205 – Common Requirements for Process Valves.

B. Eccentric Plug Valves: Unless otherwise directed, the following rules shall be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:

1. The valves shall be positioned with the stem in the horizontal direction.
2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.
3. The orientation of the valve shall prevent the valve body from filling up with solids when closed; however, where the pressure differential through the valve exceeds 25 psi, the higher pressure for valves without worm gear, electric, or air operators shall be through the valve to force the plug against the seat.
4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines) and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for the full range of sizes.
5. For special applications or when in doubt, consult with the manufacturer prior to installation.

3.02 TESTING

A. Valves shall be tested in accordance with the testing requirements specified in Section 15205 – Common Requirements for Process Valves.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01600	Products, Materials, Equipment and Substitutions
01730	Operation and Maintenance Data
15205	Common Requirements for Process Valves

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 15205 – Common Requirements for Process Valves.

B. Operation and Maintenance Manuals:

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

1.04 WARRANTY

A. Provide Warranty as specified in Section 15205 – Common Requirements for Process Valves.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with Section 01600 – Products, Materials, Equipment and Substitutions.

B. Protect valves and factory-applied coatings from damage during handling and installation. Repair any damaged areas in accordance with manufacturer's recommendations.

PART II - PRODUCTS

2.01 AIR-VACUUM AND AIR-RELEASE VALVES

A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be

constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.

D. Sewage Air Release Valves: Sewage air release valves shall vent accumulating gases during system operation. Valves shall have long float stems and bodies to minimize clogging. The same general requirements shall apply as indicated for air and vacuum valves. Each sewage air release valve shall be furnished with the following backwash accessories, fully assembled on the valve:

1. Inlet shut-off valve.
2. Blow-off valve.
3. Clear water inlet valve.
4. Rubber supply hose.
5. Quick disconnect couplings.

E. Manufacturers

1. APCO (Valve and Primer Corporation)
2. Crispin - Multiplex Manufacturing Company
3. GA Industries
4. Val-Matic (Valve and Manufacturing Corporation)

PART III - EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with this Section.

B. Air and vacuum release valves shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

C. Valves shall be easily accessible for future inspection and maintenance.

3.02 TESTING

A. Valves shall be tested in accordance with the testing requirements specified in Section 15205 – Common Requirements for Process Valves.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The Contractor shall provide fabricated stainless steel weir gates, including actuators, supports, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer

1. The Contractor shall assign to a single manufacturer responsibility for the furnishing and functional operation of the weir gates, including operators and accessories.

2. The designated single manufacturer, however, need not manufacture more than one part of the units, but shall coordinate the design, assembly, testing, and installation of the units.

1.02 RELATED REQUIREMENTS

A. Reference Specifications

01300	Submittals
01600	Products, Materials, Equipment and Substitutions
01730	Operation and Maintenance Data
05500	Metal Fabrications
09960	High-Performance Coatings
15201	Actuators for Process Valves and Gates

1.03 REFERENCES

A. Reference Standards

ASTM International (ASTM)	
ASTM A380	Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A967	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
American Water Works Association (AWWA)	
AWWA C561	Fabricated Stainless Steel Slide Gates
AWWA C542	Standard for Electric Motor Actuators for Valves and Slide Gates

1.04 DEFINITIONS

A. Slide gate is a device used for controlling the flow of water consisting of a welded, simple, vertically traveling stainless steel slide within a fixed frame using a self-adjusting seal system to accomplish sealing on four sides with a manual and/or power actuated lifting mechanism.

B. Design head (seating or unseating) is the maximum differential head that will actually be applied to the gate under worst-case conditions.

C. Descaling of stainless steel is the removal of heavy, tightly adherent oxide films resulting for hot-forming, heat treatment, welding, and other high-temperature operations. Descaling can be accomplished by mechanical or chemical methods, or a combination of the two.

1. Mechanical descaling includes the descaling through the use of abrasive blasting, power brushing, sanding, grinding, and chipping per ASTM A380.

2. Chemical descaling (pickling) is the process of descaling of stainless steel with aqueous solutions as described in Annex A1, Table A1.1 of ASTM A380.

D. Passivation is the restoration of the protective passive film on the surface of the stainless steel using chemical treatment after descaling and cleaning have been completed. The objective of the pickling and passivation processes is to produce a uniform white pickled finish.

1.05 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals.

1. Submit the following:

a. Drawings of gates, frames, slides, and actuators, showing dimensions, elevations, and materials of construction

b. Stem guide, frame, and sealing system details

c. Design load calculations for slide/yoke deflection at the design head.

d. Calculations for the lifting force generated by 40 pounds (18 kg) effort on the handwheel or crank in order to operate the gate

e. Submit manual or electric actuators with the weir gate equipment as one submittal

2. Product Data:

a. Manufacturer's literature, illustrations, specifications, and engineering data

b. Support design information: Submit for record purposes the weight of each gate and expected opening and closing thrust loads on the supporting structure

B. All engineering calculations required for submittal shall be signed by a Registered Professional Engineer at the manufacturer's expense.

C. Field Procedures

1. Prior to installation of the gates, provide instructions for field procedures for installation, adjustments, inspection, and testing.

D. Operation and Maintenance Manuals:

1. Submit O&M Manuals in accordance with 01730 – Operation and Maintenance Data.

E. Certification

1. The Contractor shall obtain written certification from the designated single manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Contract Documents, and that the designated single manufacturer accepts the Contractor's assignment of responsibility for coordination of gate equipment, including operators, controls, and services required for proper installation and operation.

F. Quality Assurance/Control Submittals

1. Welding and finishing procedure: Furnish manufacturer's welding and finishing procedure in accordance with procedures detailed in paragraph 2.04B prior to start of fabrication.

2. Field installation report: Furnish a manufacturer's service report after inspection of the gates for proper installation with the following:

a. List of deficiencies in the gate installation and the recommended corrective action.

b. Statement certifying that gates are properly installed and fully operational except for deficiencies noted.

c. Reports of factory and field performance and leakage tests per AWWA C561.

d. ISO 9001:2008 certification.

1.06 QUALITY ASSURANCE

A. Gates and appurtenances included in this specification shall be the end products of one manufacturer to achieve standardization for maintenance, spare parts, operation and manufacturer's service.

B. All equipment furnished under this Section shall be new and unused and shall be standard products of a single manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of five (5) years and having satisfactorily provided the same type of equipment in at least 50 installations. Slide gate installations used to meet this experience requirement shall be of the same design and material, be similar in size, be designed for similar hydrostatic conditions and have the same mechanical features as the gates specified in this Section.

C. Seal Performance Test: The sealing system of each gate type specified should have been tested through a cycle test in an abrasive environment on a stainless steel gate and should show that the leakage requirements are still obtained after a minimum of 25,000 cycles with minimum deterioration.

D. The fully assembled gates shall be shop inspected, tested for operation and leakage, and adjusted before shipping. Test reports shall be submitted for approval prior to shipment. There shall be no assembling or adjusting on the job sites other than for the lifting mechanism.

1.07 WARRANTY

A. The manufacturer shall warrant that the equipment supplied to be free of defects in material and workmanship for a period of one (1) year from the date of substantial completion.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with Section 01600 – Products, Materials, Equipment and Substitutions.

PART II - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Slide gates shall be designed to seal the end of a pipe or a wall opening with seals on four sides and shall follow the design criteria of AWWA C561 except as modified herein.

1. Design head (seating and unseating) as indicated in the Gate Schedule.

2. Self-contained (SC) or open frame (OF), as indicated in the Gate Schedule.

3. Self-contained (SC) gates shall utilize a yoke mounted operator, unless a torque tube (TT) is indicated in the Gate Schedule.

4. Open frame (OF) gates shall utilize a pedestal mounted operator

5. Rising stems (RS) and non-rising stems (NRS) shall be provided as indicated in the Gate Schedule, and as specified herein.

6. Downward opening (DO) and downward closing (DC) gates shall be provided as indicated in the Gate Schedule.

7. UHMW polyethylene side and top seals and a neoprene or EPDM flush-bottom seal.

8. Flange back frames for mounting directly to the wall surface, as indicated in the Gate Schedule, and as specified herein.

B. Electric motor actuators shall follow the design criteria of AWWA C542 except as modified herein.

2.02 PERFORMANCE

A. Leakage: Allowable leakage shall not exceed 0.05 gpm/ft (0.62 L/min/m) of seating perimeter under the design seating and unseating head conditions.

2.03 STAINLESS STEEL WEIR GATES

A. Fabricated stainless steel gates shall be as specified herein and have the characteristics and dimensions shown on the Gate Schedule.

B. Materials of Construction

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C561 suitable for the service.

2. Materials used in the fabrication of the slide gates shall conform to the requirements of the latest revision of the standards designated for each material as indicated below:

Description	**Material Standards**
Frame, slide, wall bracket, yoke, stem guide brackets	Type 316/316L Stainless Steel, ASTM A240
Stem, stem coupling, stem extension	Type 316/316L Stainless Steel, ASTM A276
Side and top (DC) / bottom (DO) seal, stem guide liner	UHMW Polyethylene, ASTM D4020
Invert (DC) / top (DO) seal	Neoprene, ASTM D2000, Grade 2 BC 510;

	or EPDM, ASTM 1056
Compression cord	Nitrile, ASTM D2000, M6BG 708, A14, B14, E014, E034
Gasket (between frame and wall)	EPDM, ASTM 1056
Fasteners	Type 316 Stainless Steel, ASTM A276
Stem Cover	Cellulose Acetate Butyrate, ASTM D707; Clear PVC, ASTM D1784; or Polycarbonate, ASTM D3935
Lift nut, coupling	Manganese Bronze, ASTM B584 UNS C86500
Pedestal, handwheel, crank	Tenzaloy Aluminum, Alloy ZC81 A; or Type 316L Stainless Steel, ASTM A276
Torque tube, bracket	Type 316L Stainless Steel, ASTM A276

C. Gate Frame:

1. Frames shall be stainless steel, formed or welded to form a rigid one piece frame to prevent distortion during shipment, installation, or under any operating condition of service.

2. Frames shall be self-contained or open-framed as indicated in the Gate Schedule.

3. Frames shall be of a continuous, integral flange back design to provide a rigid and flat mating surface suitable for the mounting type indicated in the Gate Schedule.

4. A mechanical stop shall be incorporated into the gate frame to limit opening travel.

5. The frame configuration shall be of the flush-bottom type and shall allow the replacement of all seats and all seals without removing the gate frame from the wall.

D. Slide:

1. Slide shall be stainless steel plate, minimum ¼-inch thick (6 mm), reinforced with stainless steel structural or formed members welded to the plate to produce a one-piece rigid unit.

2. Deflection of the slide shall not exceed 1/720 of the gate's span or 1/16-inch, whichever is less, under the design operating head.

3. Stem connection shall be designed to withstand the thrust developed by the actuators with a safety factor of 5, based on the ultimate tensile, compressive and shear strength of the material. The stem connection shall have either:

4. Structural members welded to the slide and shall have a minimum of two bolts;

5. Threaded and bolted (or keyed) block welded to the slide; or

6. Threaded and bolted (or keyed) thrust nut supported in a welded pocket.

E. Seals:

1. All side and top seals used in the gate shall be self-adjusting ultra-high molecular-weight-polyethylene (UHMWPE) with a friction coefficient of 0.2 or less. Seals shall be of the self-adjusting type and shall ensure contact between the guide and the gate in all positions. Reclaimed rubber shall not be used. J-bulb seals are not acceptable.

2. Side and top seals shall act as bearing surfaces and seals. The side seals shall contact the upstream and downstream faces of the slide to prevent metal to metal contact and reduce leakage. The top seal shall be mounted to the top frame member. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions.

3. The flush-bottom invert seal shall be made of resilient neoprene or EPDM mechanically fastened in the frame invert along the bottom of the frame.

4. The seals shall be mounted so as to maintain efficient sealing in any position of the slide and allow the water to flow only below the slide plate.

F. Guide Rails and Yoke:

1. Guide rails shall be stainless steel plate and structural angles.

2. Guide rails and yokes shall be welded or bolted to the frame to provide a one-piece rigid frame. Guide rails shall be designed to withstand the design head with a safety factor of 5, based on the ultimate tensile, compressive and shear strength of the material. Guide rails and guide rail attachment hardware shall meet the safety factors listed in AWWA C561 at a minimum.

3. The yoke shall be designed to withstand the thrust developed from the manual actuator when a 40 lb (180 N) effort is placed on the handwheel or handcrank with a safety factor of 5, based on the ultimate tensile, compressive and shear strength of the material.

4. Guide rails shall be of sufficient length to support 2/3 of the slide when in the open position.

5. Guides of enclosed frame gates extending above the operating floor shall be sufficiently strong so further reinforcing is not required.

6. Yoke of enclosed frame gates shall support lifting mechanism. The maximum deflection of the yoke shall be 1/360 of the gate's span.

7. Yoke shall be designed to allow stem and slide removal without removing the yoke or without damage to any gate component.

8. For gates with electric motor actuators, the yoke and guide rails shall withstand the output thrust of the motor actuator in the stalled-motor condition without exceeding 75 percent of the yield stress of the material.

G. Stem and Stem Couplings:

1. Rising stems (RS) shall be provided unless otherwise indicated in the Gate Schedule.

2. Non-rising stems (NRS) shall be provided as indicated in the Gate Schedule.

3. Stems shall have a minimum outside diameter (OD) of 1-1/2 inches. Stems shall be stainless steel attached to the slide with a stainless steel connector. Stem and attaching bolts and nuts shall be stainless steel.

4. The operating stem shall be designed to withstand a manual actuator tension load due to the application of 40 lb effort on the handwheel/handcrank or 50 ft-lb (70 N-m) on the wrench nut without exceeding one fifth of the ultimate tensile strength of the stem material. The operating stem shall be a critical buckling compression load assuming a 40 lb (180 N) effort on the handwheel/handcrank of 50 ft-lb (70 N-m) on the wrench nut with a safety factor of 2. The critical buckling load shall be determined using the Euler column formula where C=2. Where electric motor actuators are used, the stem design force shall not be less than 1.25 times the output thrust of the unit in the stalled-motor condition. The stem shall have a slenderness ratio (L/r) less than 200.

5. Threaded portion of the stem shall have full-depth, machine-rolled threads of the American Standard General Purpose Acme type with 16-microinch finish. Stub Acme type threads are not acceptable.

6. For stems in more than one piece, the stem sections shall be joined together by solid stainless steel couplings. The couplings shall be of greater strength than the stem.

7. Slide gates shall be provided with a field-adjustable, internally threaded bronze stop collar to set downward travel setting and prevent over-closing of the gate.

8. Rising stem gates shall be provided with a clear PVC, Butyrate, or Polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear Mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

9. All gates having a width greater than 48 inches and greater than two times their height shall be provided with multiple operating stems, stainless steel interconnecting shafts and flexible couplings with stainless steel hardware.

H. Stem Guides:

1. Guides shall be placed at sufficient intervals to adequately support the stem in accordance with the manufacturer's recommendation for each stem size. The length/radius of the gyration ratio for the unsupported part of the stem shall not exceed 200. The inside diameter of the guide shall not be greater than 1/8 inch (3 mm) larger than the outside diameter of the stem.

2. Guides shall be adjustable relative to the bracket and the bracket shall be adjustable relative to the wall to provide proper concentric alignment with the stem and shall be designed so that alignment will be maintained after adjustment.

3. For gate-mounted guides, bracket and housing shall be the same material as the gate.

4. For wall- or ceiling-mounted stem guides, bracket and guide housing shall be stainless steel. Brackets shall be attached to the wall by anchor bolts sufficient to prevent twisting or sagging under load.

5. Stem guides shall be lined with a UHMW polyethylene or bronze lining and shall have provisions to hold lining in place.

I. Wall Thimble

1. Provide wall thimbles where required by the Gate Schedule.

2. Thimbles shall be stainless steel, welded to provide a one-piece rigid unit.

3. Thimbles shall be Type F or Type E with a depth equal to the thickness of the concrete wall in which the thimble is to be located.

4. Thimbles shall have a continuous water stop along the periphery of all embedded sections and shall have holes in the bottom to allow venting of air during concrete placement.

5. Thimbles shall be provided with square to round transitions where required by the Gate Schedule and with flanged fittings as indicated by the Gate Schedule. Flanges shall conform in dimensions and drilling to ANSI/ASME B16.1, Class 125.

6. Studs and nuts shall be stainless steel.

J. Bolts, Nuts, and Studs:

1. Embedded in Concrete:

   a. Comply with Section 05500 – Metal Fabrications for Anchor Bolts, Expansion Anchors and Concrete inserts.

   b. Provide Type 316 stainless steel anchor bolts for stem guides, floorstands, and all equipment or appurtenances which must be secured to concrete walls or floors.

2. All Others: Comply with ASTM A193, Grade B7.

3. Provide ASTM A194 Grade 2H hexagon heads and nuts.

K. Lift Mechanism

1. Power lifting mechanisms shall be in accordance with Section 15201 – Actuators for Process Valves and Gates.

2. Each gate shall be manually operable by a removable handwheel or handcrank mounted on an operating nut. The manual lift mechanism shall have either a direct drive handwheel without reduction gearing, or shall be crank-actuated with either single- or double-reduction gearing, as necessary, to meet the required lifting capacity.

3. The manual lift mechanism shall be sized to permit slide operation with an effort of not more than 40 lb (180 N) pull on the handwheel/handcrank or 50 ft-lb (70 N-m) on the lift nut or input shaft, depending on the lift type. All components of the lift mechanism shall be designed to withstand these input loads or torques with a minimum safety factor of 5 with regard to tensile, compressive, and shear forces.

4. The lift mechanism shall have a bronze lift nut threaded to fit the operating stem. Tapered roller or ball thrust bearings shall be provided above and below the flange on the lift nut to take the thrust developed during gate operation. All bearings and gears shall be enclosed in a cast iron or cast aluminum housing with oil seals and O-rings or mechanical seals used to seal the unit, exclude moisture and dirt, and prevent leakage of lubricant from the unit. Fittings shall be provided so that all bearings and gears can be periodically lubricated.

5. The lift mechanism shall be supplied with a pedestal, torque tube, or baseplate designed for mounting the lift housing and ready for bolting to the operating floor, top wall mounting bracket, or gate yoke, as required.

6. Gear-reduced lifts shall have steel drive gears, accurately machined, with cut teeth to provide smooth and proper operation. Input shafts shall be stainless steel and supported by tapered rollers or other roller-type bearings designed to withstand the radial and thrust loads generated during operation.

7. All manual lifting mechanisms shall be suitable for operation by use of a portable motor apparatus after the removal of the handwheel or handcrank. This shall include, but is not limited to, any bracket required for mounting of the electric-drill or gasoline- powered portable operators to the lifting mechanism.

8. The direction of wheel or crank rotation shall be indicated on the lift mechanism. Single-speed actuators shall open counterclockwise. Two-speed actuators shall open counterclockwise for low mechanical-advantage gear ratio and open clockwise for high mechanical-advantage gear ratio.

9. Handwheel/Handcrank:

    a. Handwheels and handcranks shall be cast iron or cast aluminum.

    b. Minimum handwheel diameter is 15 inches (450 mm). Maximum handwheel diameter is 30 inches (760 mm).

    c. Minimum handcrank radius is 12 inches (300 mm). Maximum handcrank radius is 15 inches (380 mm).

    d. Handcranks shall be fitted with a corrosion-resistant rotating handle.

    e. The centerline of the handwheel and handcrank shall be between 42 inches and 48 inches above the operating floor.

10. Remote Actuator Drives:

    a. Remote actuator drive shall be provided when the centerline of the handwheel and handcrank exceeds 48 inches above the operating floor.

    b. Remote actuator drive shall be of the chain and sprocket type, with a stainless steel chain guard.

    c. The centerline of the remote handwheel and handcrank shall be 42 to 48 inches above the operating floor.

11. Pedestal:

    a. A pedestal shall be provided for each lift mechanism that is not yoke mounted or indicated as open frame (OF) in the Gate Schedule.

    b. The pedestal height shall be such that the centerline of the handwheel and handcrank is 42 to 48 inches above the operating floor.

    c. Permanently attach or cast an arrow with the word "OPEN" on the pedestal indicating the direction of rotation to open the gate.

    d. The lifting devices shall be mounted on pedestals constructed of Tenzaloy aluminum, cast iron or fabricated stainless steel with minimum ½-inch thick baseplates.

    e. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure.

12. Torque Tube:

    a. Where indicated in the Gate Schedule, the self-contained (SC) gate design shall employ a torque tube (TT) of adequate dimensions to transfer the force required to open the gate from the operator gearbox directly to the yoke of the gate frame, and shall not impose any force upon the structure.

    b. The torque tube shall function as the gate pedestal, supporting the gear box, actuator, etc. so that the manual operating nut is 42-inches above the operating floor level.

    c. The pedestal/torque tube shall be wall-mounted and supported at the operating floor level by means of a gusseted bracket constructed of Type 316L stainless steel, as indicated on the Contract Drawings.

    d. Permanently attach or cast an arrow with the word "OPEN" on the torque tube indicating the direction of rotation to open the gate.

13. Dual actuators: All gates 48 inches or wider and having a width greater than two times their height shall be provided with two lifting mechanisms connected by a stainlesssteel tandem shaft for simultaneous operation. Flexible couplings shall be provided at each end of the cross shaft.

2.04 FABRICATION

A. Workmanship:

1. The gate slide and frame shall be fabricated to within 1/8 inch (3 mm) squareness, flatness and dimensional tolerance with respect to gate opening.

2. All attaching bolt holes shall be accurately located to mounting patterns indicated on the drawings and shall be drilled or punched and free of all burrs and defects.

3. All machines parts, especially the lift mechanism and stem, shall be accurately machined with interchangeable parts, so that replacement parts can be furnished at any time and replaced in the field with minimum effort.

4. All parts shall conform to the design dimensions and shall be free from defects in material and workmanship. Castings shall be clean, sound, and without defects that could impair their function.

5. Equipment used in welding preparation shall be covered or faced to prevent mild steel contamination of stainless steel. Items shall be marked "STAINLESS STEEL," and shall be used for no other purpose.

B. Welding:

1. Gates shall be welded using the welding process described in ANSI/AWS D 1.6 or ASME Section IX.

2. Weld-joint area and surrounding metal for several inches back from the joint, on both faces of the weld, shall be cleaned immediately before starting to weld by brushing with a clean stainless steel brush or scrubbing with a clean, lint-free cloth moistened with solvent, or both.

3. Welding processes and welders shall be qualified and maintained as required by ANSI/AWS D 1.6, Section 5.

4. All welds shall be visually inspected in accordance with ANSI/AWS D1.6, Section 6 or ASME Section IX.

5. Field welding is prohibited unless approved by the Engineer.

C. Finish:

1. Gates and appurtenances shall be free of all weld slag, spatter, grease, dirt, mill scale, or other substances that could interfere with gate operation or performance, or greatly detract from its appearance.

2. Precleaning: After assembly, all grease, oil, paint, soil, grit, and other gross contaminants shall be removed from gate assemblies prior to descaling.

3. Descaling: After precleaning, gate assemblies shall be descaled per ASTM A380, paragraph 5. Chemical descaling and mechanical descaling will be permitted. Spot chemical descaling with pickling paste shall be conducted for areas that cannot be mechanically descaled. The resulting surfaces shall be free of oil, grease, rust, scale, and other foreign matter. The descaling process shall produce only a modest etch while removing all oxidation and ferrous contamination from the stainless steel surface.

4. Cleaning: Surface contaminants not removed by the descaling process shall be removed by one of the cleaning processes detailed by ASTM A380, paragraph 6.2 prior to passivation.

5. Passivation: Following descaling, removal of all descaling agents, and cleaning of all surfaces, all stainless steel gate components shall be shop passivated using the ASTM A380 method that corresponds to the applied welding procedure.

6. All residues of passivation shall be completely removed from the gate assemblies. After passivation, the gate assemblies shall exhibit a uniform finish. Etching, pitting, or frosting resulting from the passivation procedures shall not be present.

D. Shop Finishing:

1. Reference provisions under Section 09960 – High-Performance Coatings for surface preparation and painting materials.

2. Do not shop paint stainless steel gate members or actuator housings.

3. Shop paint all ferrous metal surfaces of gates and accessories.

E. Tools

1. Furnish special tools that are necessary for maintenance and repair of the gates.

2. Such tools shall be suitably stored in metal toolboxes and identified with the equipment number by means of stainless steel or solid plastic nametags attached to the box.

F. Spare Parts

1. Furnish the following spare parts in a box as described above for tools, for hydraulic-actuated gates for each type and size of gate:

   a. one set of directional valves, solenoid or pilot actuated

   b. one set of cylinder actuator seals

c. one repair kit for the hydraulic pump, containing seals or packing, gaskets, and O-rings.

2. Furnish one (1) spare lift nut for each diameter of stem.

G. Approved Manufacturers

1. Whipps, Inc.,

2. Fontaine/Aquanox

3. Hydro Gate Corp.

PART III - EXECUTION

3.01 GENERAL

A. The Contractor shall be responsible for the complete installation of the equipment including all mechanical, electrical, instrumentation and structural connections, interconnecting piping, utility connections, foundations, platforms, conduits, and all other features, accessories and appurtenances required for the successful installation and operation of the fabricated weir gates. Installation of the equipment shall be in strict accordance with the requirements of the manufacturer's written instructions and Shop Drawings.

B. Installation shall be by mechanics/millwrights skilled in this work, in direct employ or under contract to the Contractor. The installation work shall proceed under the supervision of a manufacturer employed service technician

C. Final electrical connections shall be made by qualified electricians in direct employ or under contract to the Contractor. All electrical work shall be performed in compliance with the general requirements of Division 16.

D. The equipment installed shall be checked, aligned, tested, and placed into operation.

3.02 INSTALLATION

A. Weir gates shall be installed in strict accordance with the manufacturer's printed recommendations, installation instructions, shop drawings, and the indicated requirements.

B. Operators shall be located to avoid interference with handrails and structural members.

C. Surface-mounted gates: Where wall thimbles are not provided, mount gate to wall with anchor bolts and a 1-inch grout pad in accordance with manufacturer’s recommendations.

D. Damage to surface coatings incurred during shipment or installation shall be repaired.

3.03 FIELD TESTING

A. Field testing shall be performed after installation of the weir gate prior to final acceptance. All testing shall be witnessed by the Engineer and Owner. Provide a minimum of 7 days notice before testing. Manufacturer representative to be present at the test site.

B. Leakage Test:

1. Seating and unseating heads shall be measured from the top surface of the water to the center of the gate.

2. Allowable leakage shall not exceed 0.05 gpm/ft (0.62 L/min/m) of seating perimeter under design seating and unseating head.

3. Visually inspect all seal contact points (top, bottom, sides) for leakage.

4. Measure and document leakage rates. Submit results to the Engineer for review.

5. Excessive leaks shall be corrected, and the equipment retested until found to be satisfactory.

C. Performance Testing

1. Operate each gate through at least one full open and one full close cycle.

2. Record and document the number of full 360-degree turns required to fully open and fully close each gate.

3. Note the direction of operation (e.g., "open counterclockwise").

4. Confirm smooth, unimpeded movement with no binding, sticking, or abnormal noise.

5. For motorized gates, test local and remote operation including manual override functionality.

D. Limit Switch and Indicator Testing

1. Verify that limit switches stop gate travel at full open and full closed positions.

2. Confirm position indicators function correctly at local and remote-control panels.

3. Verify correct responses to control signals from SCADA or local control systems.

3.04 MANUFACTURER'S FIELD SERVICES

A. Retain a qualified factory trained representative of the manufacturer to perform the following services:

1. Installation and Startup Assistance

   a. Check installation of all equipment and accessories specified herein.

   b. Inspect each installation and note deficiencies.

   c. Assist Contractor during operation, adjusting, and field testing of each installation.

   d. Prepare installation report and submit immediately after completion of field testing; report to include

      1) Description of installation deficiencies not resolved and recommended corrective action.

      2) Statement certifying that gates and appurtenances are properly installed in accordance with manufacturer's requirements and recommendations except for deficiencies noted above.

2. Instruction of Owner's Personnel

   a. Instruct the Owner's personnel in the operation and maintenance of the equipment.

3. Service and testing assistance by the manufacturer's engineering representative shall be furnished by the Contractor during installation and startup, minimum:

   a. 1 trip, 1 day (8 hours on site) for installation supervision

   b. 2 separate day trips, 1 day (8 hours on site) each trip for startup and training

3.05 GATE SCHEDULE

The following Gate Schedule shall apply to new gates. All new gates shall include electric actuators. Actuator service shall be OPEN/CLOSE unless otherwise indicated.

TAG NO.	DESCRIPTION	FLUID SERVICE	SIZE, IN (WXH)	MATERIAL	FRAME/ OPENING STYLE	MOUNTING	OPERATOR/ CONTROLS	DESIGN SEATING/ UNSEATING HEAD, FT	FINISHED FLOOR ELEVATION	GATE INVERT ELEVATION	REMARKS
JBOX1-MOG-01	ATR 1 INFLUENT	TF	36X30	316L SS	SC/ DO	WALL	MO/ YM/ A	2.5	448.50	449.50	V-NOTCH WEIR GATE
JBOX1-MOG-02	ATR 2 INFLUENT	TF	36X30	316L SS	SC/ DO	WALL	MO/ YM/ A	2.5	448.50	449.50	V-NOTCH WEIR GATE

NOTES:

FRAME/ OPENING STYLE:

DO: DOWNWARD OPENING

SC: SELF CONTAINED

OPERATOR:

MO: MOTORIZED OPERATOR

YM: YOKE MOUNTED

FS: FLOOR STAND

CONTROLS:

D: DISCRETE

A: ANALOG, 4-20 MA

FLUID:

TF: DEWATERED FILTRATE

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Requirements for materials and installation of plumbing systems.

1.02 REFERENCES

A. Abbreviations:

1. gpf - gallons per flush.
2. gph - gallons per hour.
3. gpm - gallons per minute.
4. psig - pounds per square inch, gauge.

B. Standards:

1. American Gas Association (AGA).
2. American Society of Mechanical Engineers (ASME).
    a. B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
    b. B16.12 - Cast Iron Threaded Drainage Fittings.
3. American Society of Sanitary Engineering (ASSE):
    a. 1070 - Performance Requirements for Water Temperature Limiting Devices.
4. American Water Works Association (AWWA):
    a. C511 - Reduced-Pressure Principle Backflow Prevention.
    b. C700 - Standard for Cold-Water Meters—Displacement Type, Bronze Main Case.
    c. C702 - Standard for Cold-Water Meters—Compound Type.
5. Americans with Disabilities Act (ADA).
6. ASTM International (ASTM):
    a. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    b. A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

c. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

d. A888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

e. B32 - Standard Specification for Solder Metal.

f. B88 - Standard Specification for Seamless Copper Water Tube.

g. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.

h. B828 - Standard Specification for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

i. C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

j. C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

k. C547 - Standard Specification for Mineral Fiber Pipe Insulation.

l. C552 - Standard Specification for Cellular Glass Thermal Insulation.

m. C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

n. C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

o. D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

p. D297 - Standard Test Methods for Rubber Products—Chemical Analysis.

q. D395 - Standard Test Methods for Rubber Property—Compression Set.

r. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.

s. D638 - Standard Test Method for Tensile Properties of Plastics.

t. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

u. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

v. D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

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

x. D2240 - Standard Test Method for Rubber Property—Durometer Hardness.

y. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

z. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

aa. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

bb. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

cc. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

dd. E96 - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.

ee. F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.

ff. F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

gg. F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

hh. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

ii. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

jj. F594 - Standard Specification for Stainless Steel Nuts.

kk. F645 - Standard Guide for Selection, Design, and Installation of Thermoplastic Water- Pressure Piping Systems.

7. International Association of Plumbing and Mechanical Officials (IAPMO):

    a. IS 03 - Copper plumbing Tube Pipe and Fittings.

8. National Electrical Manufacturers Association (NEMA):

    a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

9. Plumbing and Drainage Institute (PDI):

    a. WH-201 - Water Hammer Arresters Standard.

10. Underwriters Laboratories, Inc. (UL):

    a. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

11. United States Environment Protection Agency (EPA): Water Sense.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.

1. Buried: Piping that is installed below buildings, foundations, or finish grade, either in soil or encased in concrete in soil.

2. Exterior: Piping that is installed outside a building or within a pipe trench or tunnel.

3. Flame spread and smoke density: Burning characteristics determined in accordance with ASTM E84.

4. Interior: Piping that is installed inside a building.

5. K factor: Thermal conductivity determined in accordance with ASTM C177 or ASTM C518.

6. Mineral fiber: Fibers manufactured of glass, rock, or slag processed from a molten state, with or without a binder.

7. Water vapor permeance: Water vapor transmission determined in accordance with ASTM E96 and expressed in units of perm-inch.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Manufacturer’s instructions.

C. Shop Drawings:

1. System layout, mechanical, electrical power, and control diagrams.

2. Nameplate information.

3. Materials.

4. Coatings and linings.

5. Rough-in drawings.

6. Supports, vibration isolators, and details.

7. Primary and ancillary equipment.

8. Proposed cutting and patching.

9. Maximum recommended equipment vibration levels and field-testing method.

10. Copy of factory test results.

D. Certificates: As specified in Section 01600 - Product Requirements:
   1. American Backflow Prevention Association for backflow prevention assembly.
   2. National Science Foundation for products when specified.

E. Field testing documentation.

F. Warranties.

1.05 WARRANTY

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

PART II - PRODUCTS

2.01 PLUMBING FIXTURES

A. General:

1. ADA compliant unless specifically stated otherwise in the fixture requirements.

2. Exposed fixture fittings and piping:

   a. Polished chrome.

3. Stops:

   a. Fixtures, except showers, shall have stops at the fixtures' service.

   b. Stops for laboratory equipment, and for other equipment or fixtures for which stops have not been otherwise specified in this Section,

shall be chrome-plated straight pattern compression stops or chrome-plated angle pattern compression stops.

4. Faucets:

    a. Brass construction, 1/4 turn ceramic disc valve cartridge.

    b. Vacuum breaker.

    c. Integral check valve.

    d. Flow rates specified for an inlet pressure of 60 psig.

5. P-traps:

    a. Cast-iron, adjustable with metal strainer, gaskets, and cleanout plug.

6. Escutcheons to be used for at wall, floor, and ceiling penetrations:

    a. Manufacturers: One of the following or equal:

        1) Keeney.

        2) Plumbing Products.

    b. IAPMO listed.

    c. Material: Chrome-plated steel plate.

    d. Hinged, spring loaded, and sized appropriately for the piping.

7. Manufacturer to supply necessary mounting hardware and installation fittings suitable to complete the installation, including, but not limited to:

    a. Faucets.

    b. Brass braided hoses.

    c. Carriers.

    d. P-traps.

    e. Toilet seats.

8. Drawings indicate fixtures using designated style identifiers.

B. Service sinks:

1. General:

    a. ADA compliance not required.

b. Sink manufacturer to supply faucet, mounting hardware, and installation fittings.

c. Faucet:

1) Exposed yoke, wall- mounted, top braced.

2) Rigid spout with 3/4-inch threaded hose end and bucket hook.

3) Deliver not more than 15 gpm.

4) Manual lever.

d. Center drains with strainer.

2. Type SS-2: Stainless steel:

a. Manufacturers: One of the following or equal:

1) Advance Tabco.

2) Elkay.

b. Drop-in type.

c. Bowl:

1) Type 304 stainless steel, 18-gauge.

2) Overall nominal: 25 inches wide by 12 inches deep.

3) Rolled rims.

d. Drain:

1) Center drain location.

2) Drain kit installed.

2.02 PLUMBING AND DRAINAGE PRODUCTS

A. Water hammer arrestors:

1. Manufacturers: One of the following or equal:

a. Zurn, Shoktrol.

b. Jay R. Smith.

c. Josam.

2. Determine manufacturer model:

a. Based on Table 1 in accordance with PDI WH-201.

b. Working pressure: 125 psig.

c. Static pressure: 250 psig.

3. Temperature: 300 degrees Fahrenheit.

4. Provide water hammer arrestors on each fixture supply line branch.

5. Casing and bellows.

a. Material: Type 304 stainless steel.

b. Welded bellows.

6. Hermetically sealed air cushion.

B. Cleanouts:

1. Cleanouts:

a. Cast-iron ferrule, countersunk plug, gastight and watertight seal.

b. Adjustable cleanout head extension.

c. Nickel-bronze top and securing screw.

d. Type FCO-2: Floor cleanouts, unfinished floors.

2. Manufacturers: One of the following or equal:

a. Josam Co., 55000.

b. Zurn Ind., Inc.

3. For unfinished floors.

4. Type FCO-3: Floor cleanout, exterior, in asphalt or ground areas:

a. Manufacturers: One of the following or equal:
1) Josam Co., 55000.
2) Zurn Ind., Inc.
3) Rated for outdoor use.

C. Drains:

1. Type, shape, and size as indicated on the Drawings with connections suitable for the piping system.

a. Provide drains of one type from the same manufacturer.

2. Type FD-1: Floor drain, finished floors, pedestrian traffic:

a. Manufacturers: One of the following or equal:

1) Josam, 30000-A.

2) Zurn.

b. Round, adjustable strainer head, floor level grate.

c. Body material: Coated cast iron.

d. Strainer:

1) Material: Nickel bronze.

2) Size:

a) 6 inch diameter for 3-inch drain.

b) 8 inch diameter for 4-inch drain.

2.03 PLUMBING PIPING SYSTEMS

A. As indicated on the Drawings in the Plumbing Pipe Schedule.

B. Seamless copper water tube:

1. Type: ASTM B88:

a. Exposed copper piping or tubing: Type L hard-drawn, rigid.

b. Copper tubing buried in the ground or in plastic conduit: Type K soft annealed.

2. Fittings: Solder type forged or wrought copper.

a. Manufacturers: One of the following or equal:

1) Crawford Fitting Co., Swagelok.

2) Hoke, Gyrolok.

3) Parker.

3. Solder: ASTM B32, Alloy Grade Sb5.

4. Flux: ASTM B813.

5. Dielectric insulating unions or fittings:

a. Manufacturers: One of the following or equal:

1) Mueller Co.

2) Watts Series 3001A.

6. Special thread to tube adapters:

a. Manufacturers: One of the following or equal:

1) Crawford Fitting Co., Swagelok.

2) Hoke, Gyrolok.

3) Parker.

C. PVC piping system:

1. Pipe: Designation PVC 1120 in accordance with ASTM D1785:

a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454 B material in accordance with ASTM D1784.

b. PVC pipe: Schedule 40, unless otherwise specified.

2. Fittings:

a. Supplied by pipe manufacturer.

b. Pressure fittings: In accordance with ASTM D2466 or ASTM D2467.

c. DWV fittings: In accordance with ASTM D2665.

3. Solvent cement: In accordance with ASTM D2564:

a. Chemical service: For PVC pipe in chemical service, provide the following primer and cement, or equal:

1) Primer: IPS Corp Type P-70™.

2) Cement: IPS Corp Type 724™ cement or cement certified by the manufacturer for chemical service.

PART III - EXECUTION

3.01 GENERAL

A. Furnish and install vents required in drainage piping as part of the plumbing system, in accordance with Laws and Regulations.

B. Use anti-seize lubricant for stainless steel treads on fittings and fasteners.

3.02 INSTALLATION

A. Fixtures:

1. Rough-in fixtures and accessories in accordance with the dimensions supplied by the manufacturers of the fixtures.

2. Mount fixtures and accessories without cutting of finish surface.

B. Plumbing and drainage products:

1. Traps:

a. Install traps as near the fixtures as possible.

2. Sizes of equipment drains and of floor drains shall be as indicated on the Drawings.

C. Plumbing piping systems:

1. Cast iron soil pipe, PVC, polypropylene:

a. Where not specified otherwise, install horizontal piping with a grade of 1/4 inch per foot.

b. Provide vents, roof drains, and pipes flashed and made watertight at the roof with lead sheet flashings.

1) Minimum 4-pound lead sheet.

c. Extend flashing not less than 6 inches up the pipes, and counter flash with standard cast iron or malleable iron recessed roof couplings.

d. Extend flashing for vents up to the top of the vent and turn down into the pipe.

e. Extend flashing shields not less than 8 inches from vent and pipe in all directions.

2. Copper tube:

a. Install in accordance with ASTM B828 and IAPMO IS 03.

b. Install in straight runs, supported at intervals close enough to avoid sagging.

c. Make cuts square with a tubing cutter or with a 32-tooth hacksaw.

1) Provide a sizing tool to correct distortions.

d. Insulate piping as specified.

3.03 FIELD QUALITY CONTROL

A. Test water piping in accordance with the plumbing code as specified in Section 01410 - Regulatory Requirements.

B. Test drain, waste, and vent lines as specified and in accordance with the plumbing code as specified in Section 01410 - Regulatory Requirements.

3.04 CLEANING

A. Upon completion of installation, clean piping interior of foreign matter and debris.

B. Flush and disinfect potable water piping as specified in Section 01757 - Disinfection.

3.05 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. General prescriptive, design, and performance requirements for products and mechanical equipment used to heat, ventilate, cool, or otherwise condition or distribute indoor air.

2. Specific requirements for ductwork accessories:

   a. Dampers and damper operators.

   b. Diffusers, grills, and registers.

3. Specific requirements for refrigerant piping.

1.02 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

1. 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

2. 270 - Sound Rating of Outdoor Unitary Equipment.

3. 340/360 - Performance Rating of Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment.

4. 430 - Performance Rating of Central Station Air-handling Unit Supply Fans.

B. Air Movement and Control Association International, Inc. (AMCA):

1. 11 - Certified Ratings Program Operating Manual.

2. 210 - Laboratory Methods for Testing Fans for Certified Aerodynamic Performance Rating.

3. 211 - Certified Ratings Program — Product Rating Manual for Fan Air Performance.

4. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

5. 311 - Certified Ratings Program — Product Rating Manual for Fan Sound Performance.

6. 500 - Laboratory Methods of Testing Dampers for Rating.

7. 511 - Certified Ratings Program Product Rating Manual for Air Control Devices.

C. American Bearing Manufacturers Association (ABMA):

1. 9 - Load Ratings and Fatigue Life for Ball Bearings.

2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. American National Standards Institute (ANSI):

1. Z21.47 - Gas Fired Central Furnaces (except Direct Vent Central Furnaces).

E. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):

1. Standard 15 - Safety Standard for Refrigeration System.

2. Standard 52.2 - Methods of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

F. American Society of Mechanical Engineers (ASME):

1. RTP-1 - Reinforced Thermoset Plastic Corrosion-Resistant Equipment.

G. ASTM International (ASTM):

1. B32 - Standard Specification for Solder Metal.

2. B75 - Standard Specification for Seamless Copper Tube.

3. B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

4. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.

5. B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fitting.

6. C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

7. D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

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

9. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

10. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

11. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

12. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

H. National Bureau of Standards: NBS PS15-69 - Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment.

I. National Electrical Manufacturers Association (NEMA):

1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

J. National Fire Protection Association (NFPA):

1. 70 - National Electrical Code (NEC).

2. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

K. National Roofing Contractors Association (NRCA).

L. International Association of Plumbing and Mechanical Officials (IAPMO):

1. IS 3 - Installation Standard for Copper Plumbing Tube, Pipe, and Fittings.

M. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

N. Underwriters Laboratories, Inc. (UL):

1. 555 - Standard for Fire Dampers.

2. 555C - Standard for Safety Ceiling Dampers.

3. 555S - Standard for Smoke Dampers.

4. 900 - Standard for Air Filter Units.

1.03 SUBMITTALS

A. Where items in this Section are components of equipment or systems specified in other sections, include data for this Section's components with the equipment or system Submittal.

B. When products are specified in this Section but are not referenced in other Technical Sections, submit:

1. As specified in Section 01330 - Submittal Procedures.

2. Product data:

    a. Sufficient to substantiate specified requirements.

3. Description of coating system and instructions for field touch up and re-coating.

PART II - PRODUCTS

2.01 GENERAL

A. Technical Sections product requirements supersede conflicting requirements in this Section.

B. As specified in Section 01600 - Product Requirements.

C. Electrical:

1. Components and assemblies.

2. Carry UL listing marking.

3. In accordance with NEC requirements.

D. Fans:

1. Rated and labeled in accordance with AMCA 210 and AMCA 211.

2. Belt drive systems:

    a. Adjustable for minimum within 5 percent speed change.

    b. Rated for 150 percent of maximum motor horsepower.

E. Unitary air conditioners and heat pumps:

1. Rated in accordance with AHRI 210/240 or 340/360, AHRI 270, and AHRI 430.

2. In accordance with ASHRAE Standard 15.

3. Heating: Certified in accordance with ANSI Z21-47.

4. Refrigerant: HFC R-454B.

F. Filters:

1. Media: UL 900 listed.

G. Insulation and adhesives: In accordance with NFPA 90A requirements for flame spread and smoke generation.

H. Factory coating: For equipment with factory coatings, manufacturer to supply 2 containers (each about a pint) of the paint for Contractor/Owner touch up.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. General:

1. Environmental conditions as specified in Section 01850 - Design Criteria.

2. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

B. Fans:

3. Sharply rising pressure characteristics throughout the operating range and beyond the efficiency peak.

4. Peak operating points to be as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.

5. Bearings rated in accordance with ABMA 9 or 11 for a L10 life rating of not less than 50,000 hours.

6. Total sound power levels in the 8 octave band range in accordance with AMCA 301, not to exceed the lesser of the following or the sones level indicated on the Drawings.

Sound Power Level, decibels levels referenced to 10 to 12 watts								
Frequency, Hz	63	125	250	500	1,000	2,000	4,000	8,000
General	100	98	94	88	84	84	78	75

7. Shall comply with AMCA 11 and bear the AMCA Certified Ratings Program seal for air performance and sound performance according to AMCA 211 and AMCA 311.

C. Unitary air conditioners and heat pumps:

1. Outdoor noise levels in the 8 octave band ranges, as measured in accordance with AHRI 270 shall not exceed the following:

Octave Bands								
Unit Nominal Capacity (Tons)	**63**	**125**	**250**	**500**	**1,000**	**2,000**	**4,000**	**8,000**
0 to 5	64	70	71	74	74	71	67	67
6	79	85	78	74	71	73	66	59
7-1/2 to 10	64	70	73	79	82	78	74	67

Octave Bands								
Unit Nominal Capacity (Tons)	**63**	**125**	**250**	**500**	**1,000**	**2,000**	**4,000**	**8,000**
12 and larger	84	88	84	83	84	78	72	68

8. Capable of starting and cooling from 45 to 125 degrees Fahrenheit ambient outdoor air temperature and exceeding the maximum load criteria of AHRI 210/240 or 340/360.

9. Heat pumps capable of starting and heating at or above 0 degrees Fahrenheit outdoor ambient air temperature.

10. Minimum cooling, Energy Efficiency Ratio (EER) and Integrated Energy Efficiency Ratio (IEER), as rated in accordance with AHRI 210/240 or 340/360 for split systems and packaged units is as follows:

Equipment Type	Net Cooling Cap (Btu per hour)	EER(1)	IEER(2)
Space Constrained, Air Cooled	<30,000	11.7	N/A
Small Duct, High Velocity, Air Cooled	<65,000	12.1	N/A
Air Cooled	<65,000	13.4	N/A
Air Cooled	>65,000 and <135,000	11.2	14.8
Air Cooled	>135,000 and <240,000	11.0	14.2
Air Cooled	>240,000 and <760,000	10.0	13.2
Air Cooled	>760,000	9.7	12.5

Notes:
(1) Deduct 0.2 degrees from the required EER for units with a heating section other than electric resistance heat.
(2) IEER is only applicable to equipment with capacity control in accordance with AHRI 340/360.

11. Units with heating capabilities: Meet or exceed the following:

    a. Annual fuel utilization efficiency: 80 percent.

    b. Steady state efficiency: 80 percent.

B. Filters:

1. Efficiency: 45 to 50 percent dust spot efficiency when rated in accordance with ASHRAE Test Standard 52.2.

C. Smoke detector requirements:

1. Provide supply, exhaust, and odor control fans greater than or equal to 2,000 cubic fpm with smoke detectors:

a. Duct or fan mounted smoke detector as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2.03 DAMPERS

A. General:

1. Type, style, and size as indicated on the Drawings.

2. Components: Include with each damper:

a. Type, frame, actuators, clips, connectors, and other accessories necessary for mounting.

1) Manual actuators: Factory supplied locking quadrant on factory mounted stand-off bracket.

2) Bracket finish to match frame.

3) Electric actuators when indicated on the Drawings.

3. Leakage class, when specified, to be in accordance with AMCA 511 and product to bear AMCA Rating Seal for Air Leakage.

4. Blade seals to be mechanically attached.

5. Fire dampers and combination smoke/fire dampers to have duct access door near damper as specified in the Technical Sections.

B. Volume control and balancing type dampers (BD):
1. BD-9, Style 9; rectangular, linear volume control damper:
a. Manufacturers: One of the following or equal:
1) Greenheck, Model HCD-240.
2) Ruskin, Model CD403.
b. Class 1 leakage.
c. Frame: Aluminum hat channel.
1) 6063-T5 extruded, anodized.
2) Mounting flanges on both sides.
3) Containing concealed linkage.
d. Blades: Aluminum, airfoil shape, parallel and opposed action.
1) 6063-T5 extruded, anodized.
2) Horizontal orientation.
3) **[57]** percent opposed blades.
e. Blade axle: 1/2-inch hexagonal steel.
1) Electroless nickel plated.
2) Molded PTFE bearings.
f. Seals:
1) Blade: EPDM.

2) Jamb: Flexible metal compression.

g. Finish: Mill.

C. Backdraft dampers (BDD):

1. BDD-1, Style 1; counterbalanced backdraft damper:

a. Manufacturers: One of the following or equal:

1) Ruskin, Model CBD6.

2) Greenheck.

b. Frame:

1) Minimum depth: 2.25 inches.

2) Minimum thickness: 0.125 inches.

3) Material: 6063T5 aluminum.

4) With insect screen and water stop.

c. Blades:

1) Minimum thickness: 0.070 inches.

2) Material: 6063T5 aluminum.

3) High strength nylon bearings.

4) Elastomer edge seals.

5) Aluminum tie-bar.

6) Blades require no more than 4.25 inches clearance beyond frame when fully open.

d. Counterbalance:

1) Zinc plated bar on blades.

2) Adjustable down to 0.01-inch wg opening.

e. Finish:

1) Polyester powder.

D. Smoke and fire damper access:

1. Dampers that exceed 12 inches by 12 inches in size shall be provided with a duct access door that is no less than 12 inches square in size.

2. Dampers that are less than 12 inches by 12 inches in size shall be provided with a removable duct section allowing for damper inspection and maintenance.

    a. Removable ductwork section shall function without the use of tools and shall not be more than 4 inches away from the fire damper sleeve connection.

    b. Construction materials and static pressure ratings shall match that of the ductwork system installed.

2.04 DAMPER OPERATORS

A. General: Provide manual or electric damper operator for each damper furnished as indicated on the Drawings.

B. Manual operators by damper manufacturer:

1. Operate damper manually with a force not exceeding 20 pounds.

2. Provide with locking quadrant.

3. Provide 3/8 inch, or larger, square double-ended drive shaft adequate for required damper torque, with machined keyways allowing for mounting in 2 positions, 90 degrees apart.

4. Provide sufficient number of operators for torque required to operate damper.

2.05 DIFFUSERS, GRILLES, AND REGISTERS

A. Provide diffusers, grilles, and registers manufactured by the same manufacturer.

B. Provide style and size as indicated on the Drawings.

C. Components: Include specified style with frame, clips, connectors, and other accessories necessary for mounting.

D. Supply diffuser, grille, and register styles:

1. SR-3, Supply Register Style 3:

    a. Manufacturers: One of the following or equal:

        1) Kees, Inc.

        2) Krueger.

        3) Metal Industries, Inc., (MetalAire).

        4) Titus Manufacturing Corp, 272FL.

5) Tuttle and Bailey.

b. Type: Aero-blade series (3/4-inch) with aluminum border.

c. Installation: When duct mounted is indicated on the Drawings, provide 4-inch drop frame.

d. Faceplate:

1) Removable grille with double deflection blades spaced at 3/4 inch.

2) Front blades parallel to long dimension.

3) Gasket at frame.

e. Core:

1) Adjustable vanes.

2) Rectangular or round neck to match ducting.

f. Damper:

1) Opposed blade volume control damper suitable for use with ducting type.

2) Adjustable through the face of the unit.

g. Materials: Aluminum frame, core, damper, and faceplate.

2.06 SCREENS

A. Required on all fans and louvers unless otherwise indicated on the Drawings.

B. Characteristics and features:

1. Bird screen: 1/2-inch mesh by 14 gauge.

a. For exhaust applications.

2. Insect screens: 18 by 14 mesh.

a. For intake applications.

3. Screens and frames, same material as ductwork, hood, louver, fan, or equipment connected to screen.

4. Screens secured in frames.

2.07 FLEXIBLE CONNECTORS

A. Provide flexible duct connectors at connections to fans and other air movement equipment as indicated on the Drawings.

B. FL-1, Duct to Duct Flexible Connection:

1. Fabric shall be fire resistant, waterproof, mildew-resistant, and airtight.

a. At least 4 inches of fabric shall be exposed.

b. Flexible connections shall be in accordance with the requirements of UL and NFPA.

2. Interior locations:

a. Manufacturers: One of the following or equal:

1) Flextech Engineering.

2) Ventfabrics, Ventglas.

b. Fabric for flexible connections installed inside office areas shall be Neoprene coated glass fabric suitable for a temperature range of 20 to 180 degrees Fahrenheit and shall have a weight of at least 27 ounces per square yard and a thickness of 0.024 inches.

3. Exterior locations:

a. Manufacturers: One of the following or equal:

1) Flextech Engineering.

2) Ventfabrics, Ventlon.

b. Fabric for flexible connections exposed to sunlight or the weather shall be glass fabric coated with CSPE suitable for a temperature range of -10 to 250 degrees Fahrenheit and shall have a weight of at least 24 ounces per square yard and a thickness of 0.019 inch.

C. FL-2, Duct to Duct Flexible Connection, Corrosive Environment:

1. Manufacturers: The following or equal:

a. Ventfabrics, Ventel.

2. Fabric for flexible connections exposed to chemicals shall be glass fabric coated with Teflon™ and suitable for a temperature range of -10 to 500 degrees Fahrenheit and shall have a weight of at least 14 ounces per square yard and a thickness of 0.014 inch.

2.08 REFRIGERANT PIPING

A. Seamless copper tube:

1. Type:

a. Straight lengths: ASTM B75, USN Alloy C12200, H55 Temper.

b. Coiled lengths: ASTM B280, USN Alloy C12200, O60.

c. Outside diameter sized, minimum wall thickness in accordance with ASTM B280 and ASTM B75.

2. Non-VRF system:

a. Solder: ASTM B32, Alloy Grade Sb5.

b. Flux: ASTM B813.

2.09 CONDENSATE DRAIN PIPING

A. PVC:

1. PVC pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:

a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454 B material in accordance with ASTM D1784.

b. PVC pipe: Schedule 80 unless otherwise indicated on the Drawings.

2. Fittings:

a. Supplied by the pipe manufacturer.

b. Pressure fittings: In accordance with ASTM D2466 or ASTM D2467.

c. DWV fittings: In accordance with ASTM D2665.

3. Solvent cement: In accordance with ASTM D2564:

a. Manufacturers: The following or equal:

1) Primer: IPS Corp Type P-70™.

2) Cement: IPS Corp Type 724™ cement or cement certified by the manufacturer for chemical service.

2.10 PIPE INSULATION

A. General:

1. As specified in Section 01600 - Product Requirements.

2. Insulation thicknesses: In inches as specified in the following table.

    a. Thickness shown is nominal.

    b. Manufacturing tolerance of 15 percent variation is permissible.

Table 1. Required Insulation Thicknesses (Inches)		
Service Temperature Range(1)	**Nominal Pipe Diameters**	
	1 Inch and Less	**1.25 to 2 Inches**
100 to 200 degrees Fahrenheit	1.5	1.5
40 to 100 degrees Fahrenheit	0.5	1.0
Notes: (1) As specified in Table 2. Insulation Schedule, at the end of this Section.		

B. Insulation, Type 1:

1. Manufacturers: One of the following or equal:

    a. Aeroflex USA Inc., Aerocel® AC.

    b. Armacell®, AP Armaflex.

2. Insulation material: Closed cell elastomeric insulation.

3. Minimum temperature range: -40 degrees Fahrenheit to 220 degrees Fahrenheit.

4. K-factor at 75 degrees Fahrenheit: Not more than 0.27 Btu-inch/hour-square feet-degrees Fahrenheit.

5. Fire ratings:

    a. Flame spread: 25 or less.

    b. Smoke density: 50 or less for insulation thicknesses up to 1.5 inches.

6. Joints: Seal with the manufacturer's recommended contact adhesive to form a continuous water barrier.

C. Insulation jackets:

1. Type 1:

    a. Manufacturers: One of the following or equal:

        1) Johns Manville, Zeston® 2000 PVC.

        2) Proto Corp., LoSMOKE PVC.

        3) Speedline® Corp., Smoke-Safe™ PVC.

b. Material: Ultraviolet-resistant polyvinyl chloride jacketing, 20-mil minimum thickness.

c. Fire rating: 25 maximum flame spread, smoke developed 50 or less.

d. Color: White.

e. Overlap: 1 inch minimum at joints and fittings.

f. Joint seal: PVC solvent welded or adhesive as recommended by the manufacturer.

g. Fittings: Factory made with full thickness insulation.

D. Vapor barriers:

1. Type 1:

a. Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type 1.

b. Permeability: 0.02 perms or lower.

c. Maximum flame spread rating: 25.

d. Edge seal: Pressure-sensitive tape lap seal.

e. Circumferential joints: 4-inch wide tape or 4-inch overlap with adhesive seal.

2. Type 2:

a. Manufacturers: One of the following or equal:

1) Benjamin Foster, No. 30-76.

2) Childers Products, CP10/11 Vi-Acryl.

3) Foster Products, 36-10/46-10 Weatherite.

4) Insul-Coustic, No. I.C.-580.

b. Material: Mastic.

E. Insulation schedule:

Table 2. Insulation Schedule

Service Designation(1)	Location(2)	Insulation Type	Jacket Type	Service Temp. °F(3)	Vapor Barrier
HVAC Refrigerant	Interior or Exterior	1	1	40 to 200	Required

Table 2. Insulation Schedule					
Service Designation(1)	**Location(2)**	**Insulation Type**	**Jacket Type**	**Service Temp. °F(3)**	**Vapor Barrier**
HVAC Condensate	Interior or Exterior	1	1	Below 60	Required

Notes:
(1) Refer to the Pipe Schedule in Section 15052 - Common Work Results for General Piping for service designations.
(2) Insulation jackets are not required for interior installations that are concealed. See definitions for description of concealed locations.
(3) Unless noted otherwise, use service temperature range provided in this table to establish insulation thickness as required by Table 1.

2.11 EQUIPMENT NAMEPLATES

A. Provide a nameplate with the following markings, plainly visible after installation:

1. Manufacturer's name, trademark, or other descriptive marking to identify specific equipment.

2. Where equipment is electrically powered:

a. Supply voltage, phase, frequency, and full-load current.

b. Power source or circuit ID.

c. Short-circuit current rating based on one of the following:

1) Rating of a listed and labeled assembly.

2) Rating established utilizing an approved method.

2.12 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements.

B. Inspect fasteners for proper tightness.

C. Ship units in one piece (or modular, if required), factory assembled, piped, internally wired, and factory tested.

D. Provide:

1. Filters: 2 extra (3 total) sets per each unit with filters.

2. Sheaves and belts: 1 set for change-out for final balance per unit installed.

3. Belts: 1 extra set for each unit installed as determined by final balance.

E. Provide a 2-year supply of maintenance products as specified in the manufacturer's maintenance literature.

PART III - EXECUTION

3.10 GENERAL

A. Technical Sections execution requirements supersede conflicting requirements in this Section.

B. As specified in Section 01600 - Product Requirements.

C. Inspect fasteners for proper tightness.

D. Provide temporary closures for openings designed for airflow.

3.11 INSTALLATION

A. Examine and verify details and sections as indicated on the Drawings, ascertain adequacy, and determine conflicts in dimensions and clearances.

1. Take measurements and verify dimensions to ascertain fit of installation.

2. Ascertain structural sufficiency to support installation.

3. Ascertain that supports and openings are correctly located; otherwise cut new openings where required.

4. Confirm specified thermostat or other controls are compatible with specified equipment.

B. Install in accordance with the manufacturer's instructions.

1. Electrical products installation in accordance with NFPA 70 NEC.

2. If there are conflicts, NEC supersedes the manufacturer's instruction.

a. Notify the Engineer of conflicts.

C. Equipment and ducts:

1. Remove dust and debris before installation.

2. Protect from dust and debris by covering openings with tape or plastic during installation and until equipment is operated.

3. Adjust alignment of ducts to resolve conflicts with the work of other trades.

4. Install and wire unitary air conditioners, controls, and thermostats in accordance with the manufacturer's recommendations.

5. Provide flexible duct and flexible piping connections at connections to unitary air conditioners.

    a. FL-1 and FL-2, Flexible Connections:

        1) Install at building expansion joints and as indicated on the Drawings.

        2) Install with collar and metal band to form airtight joints.

        3) Install with minimum 4 inches of slack in fabric.

        4) Install with minimum 3 inches of specified material on each side of fabric.

        5) Exterior locations: Install sheet metal weather cover over fabric.

        6) Duct alignment shall be a maximum of 1/2-inch offset.

        7) Minimum/maximum gap shall be 2 inches and 6 inches.

        8) Lap longitudinal joints and glue in accordance with the manufacturer's recommendations.

6. Lubrication lines and fittings:

    a. Support and protect lines from source to point of use.

    b. Fittings:

        1) Bring to outside of equipment in manner such that fittings are readily accessible from outside without necessity of removing covers, plates, housings, or guards.

        2) Mount together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.

7. Concrete surfaces designated to receive non-shrink grout under equipment:

    a. Heavy sandblast concrete surface in contact with non-shrink grout.

    b. Clean concrete surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bond to non-shrink grout.

    c. Saturate concrete with water. Concrete shall be saturated surface damp at time non-shrink grout is placed.

8. Remove dust and debris from ductwork and equipment at completion of installation.

9. Set grilles, dampers, and diffusers to achieve flows and flow patterns indicated on the Drawings.

D. Refrigerant piping:

1. Support copper tubing as specified in Section 15061 - Pipe Supports and Section 15062 - Preformed Channel Pipe Support System.

2. Clean copper lines with high-pressure air after first disconnecting piping at instruments, filters, pressure reducers, valve operators, and other special devices.

3. Installation of copper tubing:

a. In accordance with ASTM B828 and IAPMO IS 3.

b. In straight runs, supported at intervals close enough to avoid sagging.

c. Make cuts square with a tubing cutter or with a 32-tooth hacksaw.

1) Provide a sizing tool to correct distortions.

4. Ream the inside of the tubing and remove burrs from the outside, holding the end of the tubing downward and preventing chips and fillings from entering the tubing.

5. Perform flaring with a flare block and yoke type screw feed flaring tool:

a. After removing the tubing from the flare block, inspect both surfaces of the flare for splits, cracks, or other imperfections.

b. Where there are imperfections, cut off the imperfect flare and prepare a new flare.

6. Insulate piping as specified in Section 15400 - Plumbing systems.

E. Gas, water piping, drains, and venting in accordance with the authority having jurisdiction and applicable codes.

F. Completed equipment installations must have confirmation that:

1. Equipment is properly assembled.

2. Equipment moves or rotates in the proper direction.

3. Shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.

4. No unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

5. Installation meets the requirements for intended use as well as the specified vibration and noise tolerances.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Positive pressurization units with filters to remove particulate and organic contaminants.

1.02 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

1. 430 - Performance Rating of Central Station Air-handling Unit Supply Fans.

B. Air Movement and Control Association International, Inc. (AMCA).

C. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):

1. Standard 52.2 - Methods of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

D. National Electrical Manufacturers Association (NEMA).

E. Underwriters Laboratories, Inc. (UL):

1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:

1. Sufficient to substantiate specified requirements.

C. Electric: Wiring diagrams.

D. Delegated Design Submittals:

1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.

2. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.

3. For equipment installed outdoors.

E. Manufacturer's recommendation for testing and/or maintenance of the product.

1.05 WARRANTY

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

1.06 MAINTENANCE

A. Extra materials:

1. Provide 2 extra (3 total) sets of filters per unit installed.

PART II - PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements and Section 15500 - Common Work Results for HVAC.

B. Unit fabrication: In accordance with AHRI 430.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. As specified in Section 15500 - Common Work Results for HVAC.

B. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

C. For equipment installed in structures designated as seismic design category C, D, E, or F.

1. Provide guided vibration isolator for fans, so that no more than 10 percent of the vibration amplitude of the fan and motor is transmitted to the supporting structure.

D. Environmental conditions: As specified in Section 01850 - Design Criteria.

2.03 CARBON FILTER UNIT (CFU)

A. Manufacturers: One of the following or equal:

1. American Air Filter. Model, SAAF™.

2. Circul-Aire Inc. Model, APS.

3. MAS Innovations. Model, AFU.

B. General:

1. Factory assembled units with cabinet, fan, filters, dampers, access sections with hinged access doors, motor, motor base, drive, and drive guard.

2. Transition sections and filler pieces required between sections are to be provided as part of the unit.

3. Provide nameplate for each CFU as indicated on the Drawings:

a. Include the following:

1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.

2) Supply voltage, phase, frequency, and full-load current.

3) Power source or circuit ID.

4) Short-circuit current rating of the panel based on one of the following:

5) Rating of a listed and labeled assembly.

6) Rating established utilizing an approved method.

7) Nameplates shall be plainly visible after installation.

4. Internal wiring to be enclosed inside weatherproof flexible UL listed conduit.

C. Housing:

1. Constructed of a minimum 1-inch deep double-walled, foam-injected panels filled with 2 pounds per cubic unit feet dense insulation. Interior seams shall be sealed to prevent leakage.

2. Minimum 18-gauge, double-wall panel construction.

a. Interior panel shall be aluminum.

b. Exterior panel shall be aluminum.

3. Access doors shall have steel reinforcements inside the panel where hinges and handles are affixed.

a. Positive locking latches to secure and compress the PVC closed cell gasket to prevent leakage.

4. Fan section, intake and discharge plenums shall be lined with flexible polyester urethane foam acoustic insulation that is non-allergenic and inert, in accordance with flammability classification UL 94.

5. Units not mounted on vibration isolators shall have rotating components internally isolated from the main unit with vibration isolators.

6. Metal surfaces shall be coated with a lift resistant alkyd primer, followed by a 2-component polyurethane coating with a low-sheen finish.

7. Openings shall be sized for face velocity of 500 feet per minute maximum at indicated airflow rates on as indicated on the Drawings.

8. Grilles shall be provided for openings.

    a. Double-deflection, adjustable type or aluminum bar grilles.

9. Provide the inlet (return) opening with an integral manual balance damper with an external position-indicating handle with locking quadrant. Dampers shall be opposed blade type.

10. Provide a duct collar for field installation of the outside air duct when necessary or as indicated on the Drawings.

D. Fan section:

1. Fans shall be backward inclined, airfoil impeller molded from glass reinforced polyamide or backward curved made from aluminum or glass reinforced polyamide.

2. Drives shall be adjustable v-belt type, with motor mounted on an adjustable slide base.

    a. Adjustable for minimum within 5 percent speed change, rated for 1.5 times maximum horsepower motor available for the scheduled fan size or model.

3. Backwardly curved wheels shall be air foil type.

4. Fans shall be statically balanced before shipment.

5. Fans shall be AMCA rated for sound and air performance.

E. Filters:

1. Type, thickness, and efficiency as specified or as indicated on the Drawings.

2. Filter frame supports:

    a. 18-gauge aluminum with aluminum casing.

3. Slide out frame with hinged access door.

4. Constructed with a contaminant control system consisting of multiple stages of filtration. Refer to the schedule for filter types by unit and stage.

5. Pre-filter requirements:

    a. Non-woven, pleated, reinforced cotton and synthetic fabric disposable type, framed filters, thickness as scheduled.

    b. Media shall be supported and retained with an aluminum track securely attached to housing.

    c. Pressure drop for clean filters at 300 feet per minute face velocity shall be 0.15-inch w.g. for 2-inch thick filters.

    d. Minimum MERV 8 rating in accordance with ASHRAE Standard 52.2.

    e. Manufacturers: The following or equal:

        1) Farr 30/30 Disposable Filters.

6. First and second media stage:

    a. Intermediate stage shall be chemical filter media, consisting of activated carbon and activated alumina impregnated with potassium permanganate.

    b. Refer to the schedules for specific chemical filter requirements, including required range of contaminant removal.

    c. Filter media shall be supported and retained with an aluminum track securely attached to the housing.

    d. Capable of handling airstreams at the expected temperature, humidity, and air contaminant ranges indicated in the schedules.

    e. Media shall be disposable in standard dumpsters. Media shall be replaced either by discarding media housing or recycling by emptying spent media and refilling with new media.

7. After-filter requirements:

    a. Final filter, where specified, is to remove airborne media from the exit air stream.

    b. Rigid filters shall have a permanent aluminum holding frame and replaceable type rigid filter cartridge with minimum efficiency of 90 to 95 percent in accordance with ASHRAE Standard 52.2.

    c. Pressure drop for clean filters at 500 feet per minute face velocity not to exceed 0.65-inch w.g.

    d. UL listed.

e. Manufacturers: One of the following or equal:

1) American Filter Co.:

a) Riga-Flo 200.

b) Varicel Farr Co.

2) Cambridge:

a) Aeropac.

2.04 ACCESSORIES

A. Flexible duct connectors:
1. As specified in Section 15500 - Common Work Results for HVAC.

B. Dampers and grilles:
1. As specified in Section 15500 - Common Work Results for HVAC.

C. Provide electrical equipment, conduit and wire as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2.05 CONTROLS AND EQUIPMENT SAFETY FEATURES

A. General:

1. Provide system controls for a complete functioning system that operates as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

B. Motor control:

1. Provide variable speed motor control by one of the two following methods:

a. Variable frequency drive.

b. Electronically commutated motor.

2. Provide external speed adjustment of the fan.

3. CFU shall accept a single 480 VAC, 3-phase power feed.

4. Provide main power disconnect switch.

5. If controls are not integrated into the unit, mount the motor controller and main power disconnect switch in NEMA Type 4 box.

C. Motor characteristics as scheduled in CFU schedule.

D. Remote monitoring and control:

1. Provide dry-contacts for the following status and alarms:

a. Failed.

b. Running.

c. Dirty Filter.

2. Provide input connections for:

a. Smoke alarm shutdown.

b. HVAC supervisory control/enable.

E. Differential pressure gauges:

1. As specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2. Provide a differential pressure gauge across the pre-filter, after filters, final filters, and fans.

a. Where more than 1 filter is used in series, each filter shall be provided with a separate gauge.

b. Pressure range of gauges shall be 3 times the clean pressure loss of the filters provided.

F. Differential pressure switches:

1. As specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2. Provide a differential pressure switch for the pre-filter, after filters, final filters, and fans.

a. Where more than 1 filter is used in series, each filter shall be provided with a separate switch.

3. Wire the differential pressure switches to provide a signal dirty filter alarm.

2.06 SOURCE QUALITY CONTROL

A. Completely factory test each unit in operating modes of filtration prior to shipping the unit. Tests shall comply with relevant codes and standards applicable to unit design.

2.07 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

B. Ship units in one piece, factory assembled, piped, internally wired, and tested.

PART III - EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

3.02 PREPARATION

A. Anchoring and bracing to structures:

1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).

2. Install anchors of type and material indicated on approved anchoring designs.

3. Install anchors with embedment indicated on approved anchoring designs.

B. Media sampling:

1. Manufacturer shall include sampling services of chemical media in the cost of purchased media without additional cost to the Owner. Manufacturer shall support media sampling services through a licensed and trained factory representative.

2. Upon testing of media at the manufacturer’s facility, furnish an analysis report to the Owner indicating spent level of media and estimated remaining life.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Adjust alignment of ducts where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

C. Wire the positive pressurization unit and controls in accordance with the manufacturer's recommendations.

D. Provide flexible duct and flexible piping connections at connections to positive pressurization unit.

3.04 TESTING

A. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.05 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Split systems.

2. Mini-split systems.

1.02 REFERENCES

A. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

1. Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.

B. Federal Specification (FS):

1. Standard 141 - Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling and Testing.

C. National Electrical Manufacturers Association (NEMA):

1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

1.03 DELEGATED DESIGN SUBMITTALS

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Catalog cuts, bulletins, and brochures:

1. Design features.

2. Load capacities.

3. Efficiency ratings.

4. Dimensions.

5. Weight: Shipping and operating.

B. Drawings:

1. Component layout and identification.

2. Views:

    a. Front, side, rear elevations, and top and bottom views, with dimensions.

    b. Connection locations including electrical, mechanical, and other.

3. Cut away drawings.

    a. Parts list.

    b. Material specification lists.

4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.

5. Details for supports, isolators, and bracing.

C. Delegated Design Submittals:

1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.

    a. For equipment installed outdoors.

D. Engineering data:

1. Manufacturer's published data for compressor, evaporator coil, condenser, evaporator fan, refrigerant, and filter.

2. Maximum equipment vibration levels and field-testing method.

3. Sound power level in each of 8 octave bands and overall Sones.

4. Fan performance curves showing specified operating condition.

5. Bearing life.

E. Manufacturer's recommendations for handling, storage, and installation.

F. Nameplate data.

G. Seismic certification.

1.05 WARRANTY

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

B. Special warranties:

1. Refrigerant compressors and closed or sealed refrigerant systems warranty duration: Provide 5-year warranty.

2. Electric heaters warranty duration: Provide 5-year warranty.

3. Evaporator and condensing coils warranty duration: Provide 5-year warranty.

PART II - PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

B. Supplied components of the unit shall be furnished and fully integrated by the unit system supplier:

1. Furnish and install piping, valves, dampers, sensors, and wiring within the unit package.

2. Provide a prewired, unit mounted control panel to dampers and sensors within the unit.

C. Motors:

1. Totally enclosed.

2. Voltage and number of phases as scheduled.

3. Compressor motors:

a. Cooled by refrigerant gas passing through windings.

b. Provided with line break thermal and current overload protection.

4. Fan and blower motors:

a. Permanently lubricated ball bearings.

b. Integral automatic reset thermal overload protection.

D. Electrical:

1. Provide a single conduit connection in the unit for both power and control wiring.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. As specified in Section 15500 - Common Work Results for HVAC.

B. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2.03 SPLIT SYSTEM H EAT PUMP UNITS

A. Manufacturers: One of the following or equal:

1. Trane:

   a. Heat Pump, Series GAM.

   b. Indoor air handling unit, Series TWR.

2. Carrier:

   a. Heat Pump, similar series.

   b. Indoor handling unit, similar series.

3. York:

   a. Heat Pump, similar series.

   b. Indoor air handling unit, similar series.

B. Refrigerant components: Refrigerant circuit including:

1. Accumulator and filter/drier.

2. Compressor.

3. Thermostatic expansion valve.

4. Gauge ports.

5. Flow control valves.

6. Circuit feed system.

7. Strainer.

8. Reversing valve.

9. Service gauge connections with gauges on suction, discharge, and liquid lines to charge, evacuate and contain refrigerant.

10. Insulate refrigerant piping as specified in Section 15500 – Common Work Results for HVAC.

C. Compressors:

1. Fully hermetically sealed, high efficiency, reciprocating or scroll type, with internal and external vibration isolation.

2. Equipped with high-pressure relief.

3. Equipped with crankcase heater.

D. Condenser fan:

1. Propeller type, direct drive, aluminum blades, dynamically balanced, and vertical discharge.

2. Permanently sealed ball bearings and permanently lubricated.

E. Heat pump coil:

1. Seamless copper tubes with mechanically bonded aluminum plate fins.

2. Heat pump coil, internal piping, and appurtenances: Factory applied phenol-formaldehyde thermosetting resinous coating.

F. Heat pump unit casing:

1. Manufactured of minimum 22-gauge galvanized steel, bonderized, corrosion protected, and exterior coated with a baked enamel finish interior primer coated. Coating shall withstand FS Test Method Standard 141 (Method 6061) 500-hour salt spray test.

2. Weatherproof design, reinforced, and braced for maximum rigidity.

3. Provide gasketed removable panels or access doors to service equipment components and connections.

4. Provide with:

a. Non-corrosive drain pan in accordance with ASHRAE Standard 62.1.

b. Minimum 3/4-inch horizontal drain connection.

c. Knockouts for utility and control connections.

d. Minimum 14-gauge steel roll formed base rail with lifting holes; provide support feet for roof mounting on units under 6 tons size.

G. Controls and equipment safety features:

1. Provide unit controls for a complete and properly functioning system. Provide, as a minimum, the following:

a. Condenser fan controls.

b. Evaporator fan controls with time delay after compressor shutdown.

c. Motor contactors.

d. 24-volt or 120-volt control circuit as scheduled; if 24-volt scheduled, provide control power transformer.

e. Manually reset circuit breakers.

f. 5-minute compressor cycle delay.

g. Check filter switch suitable for field connection remote alarm.

h. 2-stage heating and cooling.

i. Outdoor coil defrost system controls.

j. Heater controls: When auxiliary heat is scheduled, provide heat package controls to activate auxiliary heat when mechanical heating is locked out.

k. Provide with low ambient cooling option.

2. Equipment safety features, include:

a. High-pressure switch.

b. Compressor over-temperature and overcurrent.

c. Loss of charge/low pressure switch.

d. Freeze thermostat on evaporator.

e. Lock out protection.

f. When auxiliary electric heater is specified:

1) Heat limiters for primary and secondary overcurrent and thermal protection.

a) Automatic reset switches.

b) Branch circuit protection.

3. Provide dry-contacts for the following status and alarms:

a. Failed.

b. Running.

c. Dirty Filter.

4. Provide an input connection for a smoke alarm shutdown.

5. Interface to building HVAC controls:

a. Provide contacts and signals to operate unit with the HVAC control system as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

H. Electrical:

1. Provide 15-amp, 120-volt, single phase, ground fault interrupter convenience outlet at condenser unit; provide factory installed transformer, and independent fuse or breaker protection for outlet.

2. Provide power disconnect switch at each piece of unit; mount disconnect in NEMA Type 3R enclosure if exterior to unit.

I. Indoor air handling unit:

1. Indoor air section compartment: Insulated with minimum 1/2-inch thick, permanent, fireproof, odorless glass fiber material, and coated on the air side.

2. Fan:

a. Belt driven, forward curved, double inlet, centrifugal type, steel with corrosion resistant finish, statically and dynamically balanced.

b. Permanently sealed ball bearings and permanently lubricated.

c. Adjustable pitch motor pulley.

d. Where the condenser fan is 7.5 horsepower or larger, provide a variable speed or 2 speed fan.

3. Provide with ducted discharge; orientation as scheduled or as indicated on the Drawings. Provide flexible duct connector where ducts connect to units.

4. Provide with direct expansion coil aluminum drip pan and polyvinyl chloride drainpipe.

5. Filter section:

a. Provide with 2-inch filters accessible through front of unit.

b. Provide with expanded metal return air grill to cover filter section.

c. Low velocity 2-inch thick pleated filters of commercially available sizes.

d. Filter face velocity: In accordance with manufacturer’s recommendations.

e. Filters for any 1 unit shall be the same size.

f. Filter:

1) Manufacturers: The following or equal:

a) American Air Filter.

6. Provide sub-base for floor mounting with room for condensate drain; when scheduled provide outside air connection and economizer.

7. Provide manufactured fabricated equipment stand when scheduled.

8. Evaporator coil:

    a. Seamless copper tubes with mechanically bonded aluminum plate fins.

    b. Evaporator coils, internal piping, and appurtenances: Factory applied phenol-formaldehyde thermosetting resinous coating.

9. Components factory painted with optional coating suitable for corrosive environments.

2.04 MINI-SPLIT SYSTEM HEAT PUMPS

A. Manufacturers: One of the following or equal:

1. Mitsubishi, Series PUZ; when indoor air handling unit scheduled, Series PKA (wall mounted).

2. Samsung, similar series.

3. Daikin, similar series.

4. Trane, similar series.

B. Compressors:

1. Fully hermetically-sealed, high-efficiency, reciprocating or rotary or scroll-type, with rubber grommet vibration isolation.

C. Fans:

1. Indoor air fan:

    a. Direct driven with capacitor start motor; double inlet, forward curve sirocco fan, steel with corrosion resistant finish, statically and dynamically balanced.

    b. Bearings: Permanently sealed ball bearing type and permanently lubricated.

2. Outdoor condenser fan:

    a. Propeller type, direct drive, aluminum blades, dynamically balanced.

    b. Bearings: Permanently sealed ball bearing type and permanently lubricated.

D. Coils:

1. Evaporator and condenser coils: Seamless copper tubes with mechanically bonded aluminum plate fins.

2. Provide corrosion resistant finish, suitable for marine environment.

E. Refrigerant components: Refrigerant circuit including:

1. Accumulator and filter/drier.

2. Expansion device.

3. Reversing valve.

4. Flow control valves.

5. Service and gauge connections on compressor suction and discharge, and liquid lines to charge, evacuate, and contain refrigerant.

F. Controls and equipment safety features:

1. Provide system controls for a complete functioning system:

a. High and low evaporator fan speed control for cooling and heating modes.

b. Fan only operation.

c. Space temperature condition setting.

d. Vapor bellows thermostat to cycle unit to maintain space condition.

2. Equipment safety features:

a. Thermostatic base pan drain to prevent freeze up of the fan in collected condensate.

3. Provide with a low ambient cooling option.

G. Unit casing:

1. Slide-out design unit casing manufactured of high strength molded plastic with smooth finish and outdoor casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, polyester powder coating for corrosion protection.

2. Weatherproof design, reinforced and braced for maximum rigidity.

3. Provided with:

a. Accessible filter rack for filters.

b. Non-corrosive drain pan in accordance with ASHRAE Standard 62.1.

c. Horizontal drain connection.

d. Provide mini condensate pump suitable to be powered from indoor/outdoor unit.

e. Knockouts for power connections.

2.05 ACCESSORIES

A. Economizer, when scheduled provide:

1. Integrated type capable of compressor operation while modulating to utilize up to 100 percent outdoor air for cooling when outdoor air and humidity are at set acceptable levels.

2. Including:

a. Differential bulb enthalpy control.

b. Damper drive motor.

c. Gravity relief damper.

d. Low leakage dampers, not to exceed 3 percent leakage at 1-inch static pressure.

3. Differential enthalpy sensor for economizer control.

B. Sensors: As specified in Section 15936 - Instrumentation and Control Devices for HVAC.

C. Provide hail guard to protect against damage from hail and other flying debris.

D. Provide dirty filter switch with contacts for field installed remote light or alarm.

E. Provide coil guard grill to protect condenser coil from penetration by large objects.

F. Flexible duct connectors: As specified in Section 15500 - Common Work Results for HVAC.

2.06 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 15500 - Common Work Results for HVAC.

PART III - EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

3.02 PREPARATION

A. Anchoring and bracing to structures:

1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).

2. Install anchors of type and material indicated on approved anchoring designs.

3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Insulate refrigerant and condensate piping as specified in Section 15500 - Common Work Results for HVAC.

3.04 TESTING

A. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

1. Test for outdoor sound power at levels.

3.05 FIELD QUALITY CONTROL

A. Verify equipment installation operation and vibration is within the manufacturer’s submitted maximum.

3.06 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Requirements for electric unit heaters and thermostats for heaters.

1.02 REFERENCES

A. American Gas Association (AGA).

B. National Electrical Manufacturers Association (NEMA):

1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

C. Underwriters' Laboratories, Inc. (UL).

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Catalog cuts, bulletins, and brochures:

1. Design features.

2. Load capacities.

3. Efficiency ratings.

4. Dimensions.

5. Weight: Shipping and operating.

C. Drawings:

1. Component layout and identification.

2. Views:

a. Front, side, rear elevations, and top and bottom views, with dimensions.

b. Connection locations including electrical, mechanical, and other.

3. Cut away drawings:

    a. Parts list.

    b. Material specification lists.

4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.

5. Details for supports, isolators, and bracing.

D. Delegated Design Submittals:

1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.

    a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.

    b. For wall mounted equipment weighing 125 pounds or more.

E. Engineering data:

1. Manufacturer's published data for fan, burner, and filter.

2. Maximum equipment vibration levels and field-testing method.

3. Sound power level in each of 8 octave bands and overall Sones.

4. Fan performance curves showing specified operating condition.

5. Bearing life.

F. Manufacturer's recommendations for handling, storage, and installation.

G. Nameplate data.

H. Seismic certification.

I. Vendor operation and maintenance manuals: Manufacturer's standard instruction manual for operation and maintenance.

1.05 WARRANTY

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

PART II - PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. As specified in Section 15500 - Common Work Results for HVAC.

B. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2.03 ELECTRICAL UNIT HEATER (EUH)

A. Manufacturers: One of the following or equal:

1. Indeeco, Type TRIAD.
2. Trane.
3. Markel.
4. Chromalox.

B. Fan type: Aluminum axial flow:

1. Provide fan guards.
2. Dynamically balance.
3. Fan designed for quiet operation.
4. Permanently lubricated ball bearings.
5. Automatic reset thermal overload protection.

C. Heating element characteristics:

1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
2. Fin type, Type 316 stainless steel plated heater elements, with elements brazed to common fins, designed for maximum strength and maximum heat transfer.
3. 3-phase designed for balanced phases.
4. Over temperature cutout with automatic reset.

D. Features:

1. Built-in magnetic contactors.

2. Control transformer for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

3. Required mounting brackets.

4. Individually adjustable outlet louvers.

5. Heavy 16 gauge stainless steel louvered outlet grille and plated rear grille.

6. Cabinet formed of minimum thickness 18-gauge steel with steel stiffeners. Listed for corrosive areas and NEMA 4X hose down requirements.

7. Controls:

a. Provide thermostat as specified in this Section.

b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

E. Finishes:

1. Casing finish backed enamel in manufacturer's standard color.

2.04 THERMOSTATS FOR UNIT HEATERS

A. Type: Wall mounted, heat only with fan AUTO-ON selector switch when fan part of unit and separate system ON-OFF selector switch.

B. Dial or lever temperature setpoint adjustment with 45 to 90 degrees Fahrenheit setpoint range.

C. Setpoint and temperature indication.

D. Control voltage as indicated in the Heating Unit Schedules.

E. Bi-metallic contacts suitable for 1- or 2-stage unit heater control as specified for the heater size or as scheduled.

2.05 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

PART III - EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

3.02 PREPARATION

A. Anchoring and bracing to structures:

1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).

2. Install anchors of type and material indicated on approved anchoring designs.

3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

3.04 TESTING

A. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.05 FIELD QUALITY CONTROL

A. Verify equipment operation is within manufacturer's standards and that noise levels do not exceed levels specified.

3.06 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Metal ductwork.

1.02 REFERENCES

A. ASTM International (ASTM):

1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. HVAC Systems-Duct Design.

2. HVAC Duct Construction Standards, Metal and Flexible.

C. Underwriters Laboratories, Inc. (UL):

1. 181A - Closure Systems for Use with Rigid Air Ducts.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:

1. Duct and component material and details of construction.

2. System layout, including floor and wall penetrations.

3. Supports and anchoring details.

4. Components used in the duct system, including turning vanes, dampers, flexible connections, and access doors.

C. Shop Drawings.

1.04 WARRANTY

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

PART II - PRODUCTS

2.01 GENERAL

A. Materials:

1. As specified in Section 01600 - Product Requirements.

2. Ducts:

   a. Aluminum: Aluminum alloy 3003 H14 in accordance with ASTM B209.

3. Reinforcing: Formed or extruded angles matching ductwork material.

B. Changes in duct size:

1. Use uniformly tapering sections.

2. Taper not more than 1 inch in 5 inches of run unless otherwise indicated on the Drawings.

C. Bends: With the exception of miter bends, inside radii of bends to be equal to or greater than the largest duct dimension.

D. Existing conditions:

1. Field verify existing dimensions, elevations, and conditions prior to Shop Drawing preparation and fabrication.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Pressure allowance:

1. Sheet metal construction shall conform to a minimum pressure classification of 2 inches of water gauge, negative and positive pressure, unless otherwise indicated on the Drawings or specified.

2. In accordance with the SMACNA HVAC Systems-Duct Design manual.

   a. Sheet metal thicknesses: The greater of the SMACNA design or:

Minimum Gauge (B&S) for 2-inch Water Gauge Static Pressure			
Diameter or Largest Dimension of Rectangular Duct (Inches)	**Galvanized Steel**	**Stainless Steel**	**Aluminum**
Up to 12	24	24	21
13, 14	22	22	20
15 to 18	20	20	18
19, 20	18	18	16
21 to 26	16	16	15

Minimum Gauge (B&S) for 2-inch Water Gauge Static Pressure			
Diameter or Largest Dimension of Rectangular Duct (Inches)	**Galvanized Steel**	**Stainless Steel**	**Aluminum**
Larger than 27	14	14	13

b. Spacing of hangers and supports:

1) In accordance with SMACNA but no greater than that indicated on the Drawings.

2) 8 feet on center for ducts 18 inches and smaller in the largest dimension.

3) 4 feet on center to ducts over 18 inches in the largest dimension.

c. Support connections:

1) In accordance with SMACNA unless indicated on the Drawings.

2) As a minimum, all support connections to metal or wood roofs at roof framing members only.

3) No penetrations through roof deck, roof membrane, or connections to roof membrane.

2.03 COMPONENTS

A. Duct sleeves:

1. Install where ducts pass through concrete or masonry walls and slabs.

2. Size: 2 inches larger than the duct or duct with external insulation.

3. Flanges: 4-inches wide.

B. Access openings:

1. Install in locations for access to dampers, fusible links, controllers, and similar devices.

2. Size: 2 inches less than duct size.

3. Doors:

a. Gauge not less than duct sheet.

b. Provide continuous hinge and latch on outside.

4. Gasket: Along door periphery.

5. Visual panel: 1/8-inch thick, clear Plexiglas.

C. Turning vanes:

1. Install at 90-degree bends.

a. Square-turn elbows, smooth radius elbows, and splitters.

2. Material: Same as ductwork.

3. Type:

a. Single-blade vanes for duct widths less than 36 inches.

b. Airfoil type vanes for duct widths of 36 inches and greater:

1) No trailing edge.

4. Mounted in side rails.

5. Size: 2-inch blades for ducts up to 18 inches, 4-1/2 inch blades for larger ducts.

D. Flexible connectors:

1. Install at connections to air handling equipment and at other locations indicated on the Drawings.

2. As specified in Section 15500 - Common Work Results for HVAC.

E. Splitter dampers:

1. Provide at branch take-offs where necessary for balancing the system.

2.04 FABRICATION

A. Fabricate ductwork to the configuration and outer dimensions indicated on the Drawings.

B. Ductwork specified with insulation to be sized as indicated on the Drawings. Do not increase duct dimensions by thickness of insulation when internal insulation is specified.

C. Do not utilize S clips, duct tape, or externally applied mastic on medium pressure duct systems.

D. Do not use snap lock seams.

2.05 SHIPPING

A. As specified in Section 01600 - Product Requirements and Section 15500 - Common Work Results for HVAC.

PART III - EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements and Section 15500 - Common Work Results for HVAC.

3.02 INSTALLATION

A. Hangers:

1. Install as indicated on the Drawings.

2. When hangers are not detailed, conform to SMACNA HVAC Systems-Duct Design Manual standards and the following requirements:

a. Rectangular ducts concealed in ceiling spaces:

1) Use metal strap hangers.

2) Fasten to sides of duct with 2 screws.

3) Fasten to bottom of duct with 1 screw.

b. Rectangular ducts in exposed areas:

1) Install shelf angle trapeze hangers or Unistrut type hangers.

c. Round ducts in exposed areas:

1) Install 2 half-round bands with rods bolted to panels.

B. Provide closed-cell neoprene gaskets at flanged joints.

C. Tapes and mastics used to seal ductwork shall be listed and labeled in accordance with UL 181A and shall be marked.

3.03 FIELD QUALITY CONTROL

A. Inspect ductwork under operating conditions.

1. Correct audible leaks and leaks that can be felt with the hand.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Fans, motors, and accessories.

1.02 REFERENCES

A. Abbreviations:

1. As used in this Section and on the Drawings, abbreviations and Fan Schedule headings have the following meaning:

a. EF or EXF: Exhaust fan.

b. Hp: Fan motor horsepower.

c. SF or SPF: Supply fan.

d. Size: Nominal fan blade or wheel diameter in inches.

e. SP or ESP: Fan external static pressure in inches water column.

f. Type: Fan type as specified in this Section.

g. V/Ph: Fan motor voltage and power phases.

B. Standards:

1. Air Movement and Control Association International, Inc. (AMCA).

2. American Bearing Manufacturers Association (ABMA):

a. 9 - Load Ratings and Fatigue Life for Ball Bearings.

b. 11 - Load Ratings and Fatigue Life for Roller Bearings.

3. ASTM International (ASTM):

a. A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.

b. D4167 - Standard Specification for Fiber Reinforced Plastic Fans and Blowers.

c. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

4. National Fire Protection Association (NFPA):

    a. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

5. National Roofing Contractors Association (NRCA).

6. Occupational Safety and Health Administration (OSHA).

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:

1. Materials.

2. Primary and ancillary equipment.

3. Sound power level in each of 8 octave bands and overall sones.

4. Fan system layout, mechanical, electrical power, and control diagrams.

5. Supports, vibration isolators, and seismic bracing calculations and details.

6. Calculated fan vibration levels and field-testing method.

7. Bearing life.

8. Fan performance curves showing specified operating condition.

C. Drawings:

1. Component layout and identification.

2. Views:

    a. Front, side, rear elevations, and top and bottom views, with dimensions.

    b. Connection locations, including electrical, mechanical, and other.

3. Cut away drawings.

    a. Parts list.

b. Material specification lists.

4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.

5. Details for supports, isolators, and bracing.

D. Delegated Design Submittals:

1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.

a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.

b. For equipment installed outdoors.

c. For wall mounted equipment weighing 125 pounds or more.

E. Manufacturer's recommendations for handling, storage, and installation.

F. Nameplate data.

G. Vendor operation and maintenance manuals: Manufacturer's standard instruction manual for operation and maintenance.

H. Provide manufacturers reports on factory testing.

PART II - PRODUCTS

2.01 GENERAL

A. As specified in Section 15500 - Common Work Results for HVAC.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2.03 TYPE 14, CENTRIFUGAL SIDEWALL EXHAUST FANS

A. Manufacturers: One of the following or equal:

1. Greenheck, CUBE - WALL.

2. Loren Cook, similar series.

3. Penn, similar series.

B. Characteristics:

1. Wall-mounted, upblast circular exhaust fan unit.

2. Backward inclined centrifugal fan wheel with Venturi inlet; performance as scheduled.

3. Materials: Aluminum fan, housing, and accessories.

4. Fan bearings: Permanently lubricated ball bearing type.

5. Motor characteristics: As scheduled.

6. Finishes: Provide 2.0 to 3.0-mils thick polyester powder coat or approved equal finish on fan and accessories.

C. Accessories:

1. Mounting brackets: Necessary for installation.

2. Provide other accessories as scheduled.

2.04 SOURCE QUALITY CONTROL

A. Factory test fans listed on the Fan Schedule for proper operation, performance, and electrical controls.

2.05 SHIPPING, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

B. Deliver units in 1 piece, factory assembled, internally wired, and lubricated.

PART III - EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements with additional requirements in Section 15500 - Common Work Results for HVAC.

3.02 PREPARATION

A. Anchoring and bracing to structures:

1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).

2. Install anchors of type and material indicated on approved anchoring designs.

3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

3.04 TESTING

A. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.05 FIELD QUALITY CONTROL

A. Verify equipment operation and unit vibration is within the manufacturer's submitted maximum.

3.06 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Section includes:
   1. Controls for heating, ventilating, and air conditioning (HVAC) systems.

1.02 REFERENCES

A. CSA International (CSA).

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

D. Restriction of Certain Hazardous Substances (RoHS).

E. Underwriters Laboratories, Inc. (UL):
   1. 13 - Standard for Safety Power-Limited Circuit Cables.
   2. 268A - Standard for Smoke Detectors for Duct Application.
   3. 508 - Standard for Industrial Control Equipment.
   4. 1479 - Fire Tests of Through-Penetration Firestops.
   5. 1685 - Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15500 - Common Work Results for HVAC.

C. Shop Drawings:

   1. Manufacturer’s information, including:

      a. Catalog information clearly marked to show specific products, models, and sizes being furnished.

      b. Component cut sheets.

   2. Control diagrams showing the interconnection of control components, including wiring terminal strip diagrams.

   3. Detail drawings showing control panel layout and dimensions, including control panel terminal strips for wiring to outside control devices and panels.

D. Provide vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Manuals.

1.04 QUALITY ASSURANCE

A. Control system shall be designed in accordance with UL and CSA standards.

1.05 DELIVERY STORAGE AND HANDLING

A. System control products shall be stored and handled in accordance with the manufacturer's recommendations.

1.06 SITE CONDITIONS

A. Elevation and ambient conditions as specified in Section 01850 - Design Criteria.

1.07 WARRANTY

A. Special warranties: Warranty period begins at date of Project acceptance or first date of beneficial use by the Owner.

1. 1 year parts and on-site labor for components, systems, and programming.

PART II - PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General requirements:

1. Electrical components shall be UL-listed and meet the design and installation requirements of the NEC.

2. Provide necessary electrical power and control systems, components, and wiring to make a complete functioning system.

3. Comply with electrical sections for electrical power and control systems.

4. System control functions to perform as described in Products.

5. Materials: New, free from defects, and of the quality specified.

6. Common manufacturer: Provide components, component accessories, and devices, as much as possible, by the same manufacturer throughout the Work.

7. Mount control components and devices in accessible locations for maintenance and as recommended by the manufacturer. Provide necessary manufacturer-approved mounting and configuration

hardware for mounting and operation of control components and devices.

B. Fire detection system design requirements:

1. Provide supply and exhaust fans greater than 2,000 cubic feet per minute with a smoke control system, including the following minimum components:

a. Fan and air handling unit interlocks interlock to shut down upon smoke detection signal from fire alarm control panel.

b. Field wiring terminal blocks for connection of shut down signals from local fire alarm control panel.

2.02 THERMOSTATS

A. General:

1. Thermostat types: Called out on the drawings by the letter T followed by a number.

a. This designation refers to the specified thermostat types specified in this Section.

b. Where no type is called out, provide one of the specified types that will match the controlled equipment requirements and provide a functioning system.

2. Manufacturers: One of the following or equal:

a. Honeywell, Tradeline, equivalent models.

b. Johnson Controls, model as specified with each type.

3. Thermostat cable:

a. Conductor: Number of conductors required to be determined by HVAC system, solid bare copper, 18/20 American Wire Gauge (up to 250 feet). Provide sufficient length to accommodate the thermostat locations as indicated on the Drawings.

b. Insulation: Heat and moisture resistant colored polyvinylchloride (PVC) or Polypropylene insulation.

Thermostat Terminal	Wire Color (Typical)	Function Description
R	Red	24 V Single Transformer - AC/Heat
Rc	Red	24 V for Dual Transformer - AC
Rh	Red	24 V for Dual Transformer - Heat
C	Black/Blue	Common 24 VAC Power Source

Thermostat Terminal	Wire Color (Typical)	Function Description
Y	Yellow	Primary Cooling
Y2	Light Blue/Yellow	Secondary Cooling
W	White	Primary Heating
W2	Brown	Secondary Heating
G	Green	Fan Relay
O	Orange	Reversing Valve

c. Jacket: White or brown PVC.

d. In accordance with:

1) UL 13 in accordance with NEC Article 725.

2) UL listed Type CL2, Sunlight Resistant.

3) UL 1685 Vertical Tray. RoHS compliant.

e. Temperature rating: 140 degrees Fahrenheit.

f. Voltage rating: Up to 150 V.

B. T-2, Type 2 Thermostat, Cooling Only, Line Voltage:

1. Manufacturers: The following or equal:

a. Johnson Controls:

1) Dry locations (no hose bibs or open water processes in room): Model A19BBC-2C in NEMA 1 enclosure.

2) Wet locations (hose bibs or open water processes in room): Model A19QSC-1C in rain and dusttight enclosure.

2. Switch action: SPDT, close on rising temperature.

3. Sensing element: Coiled bulb and capillary.

4. Setpoint: 30 to 110 degrees Fahrenheit with knob adjuster and visible scale.

5. Electrical ratings: 16 A at 120 VAC, 9.2 A at 208 VAC.

6. Differential range:

a. Dry locations: 3 to 12 degrees Fahrenheit adjustable.

b. Wet locations: 5 degrees Fahrenheit fixed.

2.03 DIFFERENTIAL PRESSURE GAUGES

A. Gauges for local indication of indoor units shall be accurate to within 2 percent of full scale.

1. Zero adjustment screw and an adjustable set point indicator.

2. Casing shall be cast aluminum.

3. Unit shall be able to withstand an overpressure of 15 pounds per square inch gauge.

4. Each gauge shall be provided with shut-off vent valves each side of the gauge to permit zeroing of the gauge without disconnecting the gauge.

5. Manufacturers: The following or equal:

a. Dwyer, Magnehelic Series 2000.

2.04 DIFFERENTIAL PRESSURE SWITCHES

A. Suitable for monitoring pressure drop in non-hazardous spaces.

1. Manufacturers: One of the following or equal:

a. Dwyer, Model EDPS series.

b. Omega.

2. Characteristics and features:

a. Service:

1) Air and other non-combustible, non-aggressive gases.

b. Materials:

1) Diaphragm: Silicone.

2) Housing: Acetal plastic.

3) Switch body: PA 6.6.

4) Cover: Polystyrene.

c. Temperature limits: -4 to 185 degrees Fahrenheit.

d. Pressure limits: Maximum 40-inches water column.

e. Switch type: SPDT.

f. Electrical rating: 1.5 A, 120 V.

g. Enclosure: NEMA 3.

h. Approvals: ETL approved to UL 508.

2.05 DUCT MOUNTED SMOKE DETECTORS

A. General:

1. Provide duct mounted smoke detectors in air ducting with flows greater than 2,000 cubic feet per minute as indicated on the Drawings.

2. Capable of mounting to rectangular or round ducts.

3. Integral filter to reduce dust.

4. Comply in accordance with UL 268A for air handling systems.

5. Airflow velocity: 100 to 4,000 feet per minute.

6. Connect the smoke detector to:

a. Building fire alarm system.

b. Fan control circuit to shut down respective fan upon detection of smoke.

c. Damper control circuits to close respective air dampers to prevent spread of smoke.

B. Non-Classified Areas (SD-1):

1. Manufacturers: The following or equal:

a. System Sensor, InnovairFlex Series D4120.

2. Characteristics:

a. Photoelectric type.

b. UL 268A listed.

c. Enclosure: NEMA 4.

d. Operating temperature range of -4 to 158 degrees Fahrenheit.

e. Power supply voltage: 120 VAC.

f. Contacts:

1) Alarm: SPST rated for 2 A at 30 VDC.

g. Auxiliary contacts: DPDT, rated for 10 A at 30 VDC/10 A at 250 VAC.

C. Corrosion Proof, Non-Explosion Proof, Non-Classified Areas (SD-4):

1. Manufacturers: The following or equal:

   a. Air Products and Controls, RT-3000-P.

2. Characteristics:

   a. Photoelectric type.

   b. UL 268A listed.

   c. Enclosure: NEMA 4X.

   d. Operating temperature range of -4 to 140 degrees Fahrenheit.

   e. Power supply voltage: 115 VAC.

   f. Contacts:

      1) Alarm:

         a) Form C, rated at 10 A at 125 VAC (2 sets).

         b) Form A, rated at 1 A (FACP) at 30 VDC (1 set).

      2) Fault:

         a) Form C, rated at 10 A at 125 VAC (1 set).

         b) Form B, rated at 7 A (FACP) at 30 VDC (1 set).

D. Accessories:

1. Provide metal sampling tube and end cap to match duct width. Sampling tube shall be able to be installed without use of tools.

2. Provide mounting base and hardware.

3. Provide duct access door as specified in Section 15812 - Metal Ducts. Provide similar for non-metallic ducting.

4. Provide remote annunciator with alarm and power LEDs and required wiring and conduit in accordance with installation instructions for complete working operation.

5. Provide remote test station and required wiring and conduit in accordance with installation instructions for complete working operation.

2.06 RESISTANCE TEMPERATURE DETECTOR (RTD) TYPE TEMPERATURE TRANSMITTER

A. Manufacturers: One of the following or equal:

1. Greyston Energy Systems Inc., Model TDHRBF12XA002.

2. Omega Engineering, Model EWSA-PT100-TX.

B. Characteristics and features:

1. Sensor: Platinum RTD 100 ohm or 1,000 ohm.

2. Power supply: 10 to 30 VDC, loop powered.

3. Probe sensing range: 32 to 158 degrees Fahrenheit.

4. Output signal: 4-20 mA.

5. Transmitter accuracy: Within 0.1 percent of span.

6. Enclosure:

a. NEMA 4X (IP65) for non-hazardous areas.

b. NEMA 7 for hazardous areas.

7. Wiring connection: Screw terminal block, 2-wire.

2.07 HVAC CONTROL DESCRIPTIONS

A. Provide control systems that will maintain room or area comfort under changing ambient conditions and varying use. Descriptions in this Section are general in nature and do not cover every mode of operation.

B. Blower Building Control Descriptions:

1. Blower Room:

a. Exhaust fans EF-01 and EF-02 are each provided with a hand/off/auto switch. In “hand” mode, the fan energizes. In “off” mode, the fan de-energizes. In “auto” mode, the fan is controlled by a thermostat with an adjustable set point. The fans are set in a lead/lag configuration. The lead unit’s cooling set point is 80 degrees Fahrenheit. The lag unit’s cooling set point is 85 degrees Fahrenheit. The thermostat dead band is 5 degrees Fahrenheit.

b. Electric Unit Heaters EUH-01, EUH-02, EUH-03, and EUH-04 are each provided with a thermostat with an adjustable setpoint. The

heating setpoint is 55 degrees Fahrenheit. The thermostat dead band is 5 degrees Fahrenheit.

2. Office:

   a. Mini-split heat pump system AHU-03/HP-03 is provided with a programmable thermostat with adjustable setpoints. The cooling setpoint is 75 degrees Fahrenheit. The heating setpoint is 70 degrees Fahrenheit. The thermostat dead band is 3 degrees Fahrenheit.

3. Electrical Room:

   a. Split system heat pump units AHU-01/HP-01 and AHU-02/HP-02 are each provided with a programmable thermostat with adjustable setpoints. The systems are set in a lead/lag configuration. The lead unit's cooling/heating set point is 85/55 degrees Fahrenheit, respectively. The lag unit's cooling set point is 90/55 degrees Fahrenheit, respectively. The thermostat dead band is 3 degrees Fahrenheit. The unit designations should be rotated regularly to promote equal wear and tear.

      1) Each split system is provided with a differential pressure switch that sends a "dirty filter" signal to SCADA upon detection of high pressure.

      2) Each split system is capable of sending a "general HVAC fault" signal to SCADA.

   b. A Resistance Temperature Detector (RTD) sends a "hi-temp" alarm to SCADA upon detection of high temperatures.

   c. Carbon Filter Unit CFU-01 operates continuously to scrub odors from the space.

      1) CFU-01 is provided with a differential pressure switch that sends a "dirty filter" signal to SCADA upon detection of high pressure.

PART III - EXECUTION

3.01 PREPARATION

A. Before installation remove dust and debris from equipment and accessories.

B. During installation and until equipment is operated, protect equipment and accessories from dust and debris.

3.02 INSTALLATION

A. Install as indicated on the Drawings in accordance with NFPA 90A and the manufacturer's written instructions.

B. Coordinate installation of HVAC control systems with other trades.

1. Prior to installation, coordinate wiring and conduit requirements with the electrical subcontractor.

C. Mount remote annunciator and test station on wall near smoke detector.

1. Devices shall be easily accessible from floor level.

2. Label annunciator and test station.

D. Provide electrical work to support smoke detector.

1. Coordinate with electrical subcontractor.

E. Thermostat cable conduit installation:

1. As specified in Section 16010 - General Requirements for Electrical, Section 16050 - Common Work Results for Electrical, Section 16123 – 600-Volt or Less Wires and Cables, and Section 16130 - Conduits.

F. Sensor and control station mounting:

1. Where not otherwise indicated, mount 5 feet above floor or walking level.

2. Provide insulating back plates when mounting is on an exterior wall or a wall adjoining an unconditioned space.

3. Shield outside thermostats or sensors from the sun. Provide thermostats with remote bulb and compensated capillary.

4. Install locking covers where indicated on the Drawings.

3.03 TESTING

A. Test witnessing: Witnessed.

B. Test each control component and system as part of HVAC system testing, adjusting, and balancing as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Testing air systems installed as part of this Contract.

2. Testing existing air systems affected by the installation of new equipment.

1.02 REFERENCES

A. Associated Air Balance Council (AABC):

1. National Standards Total System Balance.

B. National Environmental Balancing Bureau (NEBB):

1. Procedural Standards for Testing, Adjusting, and Balancing Environmental Systems.

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. HVAC Systems - Testing, Adjusting, & Balancing.

D. Testing, Adjusting, and Balancing Bureau (TABB):

1. TAB Procedural Guide.

1.03 SUBMITTALS

A. Resumes of proposed supervisor and personnel showing training and qualifications.

1. Include courses, exams, or tests relating to HVAC testing - taken and passed.

B. Testing plan:

1. At least 30 days prior to starting field work.

2. Set of report forms completed with design flow values and installed equipment pressure drops, and required cubic feet per minute for air terminals.

3. Heating, ventilating, and air conditioning system schematic similar to Figure 6-1 in SMACNA HVAC Testing, Adjusting, & Balancing.

a. Complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each showing:

b. Manufacturer and model number.

c. Description and use when needed to further identify instrument.

d. Size or capacity range.

e. Latest calibration date.

4. Proposed schedule for testing and balancing.

C. Report:

1. Not more than 45 days prior to the Contractor's request for final inspection, submit the draft report on applicable reporting forms.

2. At least 15 days prior to the Contractor's request for final inspection, submit 3 copies of final reports incorporating the Engineer's comments on the draft report.

3. List of instruments used and last date of calibration of each.

4. Procedures followed for testing, adjusting, and balancing.

5. Identification and succinct description of systems included in report.

6. Initial balance test results made with dampers and air control devices in full open positions.

7. Description of final locations and sizes, including opening area and dimensioned configuration of orifices and other restrictions used to achieve final balanced flows.

8. Description of final location and opening positions of dampers, registers, louvers, and valves.

9. Schematics of systems included in report; use schematics as part of testing, adjusting, and balancing report to summarize design and final balanced flows.

10. Testing, adjusting, and balancing report forms.

11. Final field results established for system balancing, including airflow, fan speeds, and fan static pressures at the fan inlet and outlet.

12. Appendices.

a. Raw field data taken during testing.

b. Sample calculation sheet for each type of calculation made to convert raw field data to final results.

c. Initial air balance results with dampers and registers in full open position; include airflow at all inlets and outlet, initial fan speed, and fan suction and discharge pressures.

PART II - PRODUCTS (NOT USED)

PART III - EXECUTION

3.01 EXAMINATION

A. Work of testing, adjusting, and balancing of heating, ventilation, and air conditioning systems to be by an independent testing agency and a certified member in good standing with AABC, NEBB, or TABB.

B. Field testing to be performed or directly supervised by personal who have passed a test and balance course or exam and is an AABC, NEBB, or TABB certified supervisor.

3.02 PREPARATION

A. Prior to start of testing, adjusting, and balancing, verify that:

1. System installation is complete in accordance with the requirements for completed equipment installations specified in Section 15500 - Common Work Results for HVAC and capable of full operation.

2. Outside conditions are within reasonable range relative to design conditions.

3. Lighting fixtures are energized.

4. Special equipment such as computers, laboratory equipment, and electronic equipment are in full operation.

5. Requirements for preparation for testing and balancing have been met for elements of each system which require testing.

3.03 FIELD QUALITY CONTROL

A. Test, adjust, and balance each separate complete heating, ventilating, and air conditioning systems.

1. Include existing heating, ventilating, and air conditioning components when affected by the Work.

B. Perform testing, adjusting, and balancing cycles until airflows meet acceptance criteria.

1. Ascertain airflow balance between overall requirements and flow in individual supply and exhaust grilles.

C. Initial testing, adjusting, and balancing:

1. Test each system with dampers, grilles, orifices, and other variable airflow devices in their full open position; measure and report initial airflows, fan speed, and fan static pressures at fan inlet and outlet.

2. Adjust total system flow downward or upward by adjusting fan speed until one inlet or outlet is at indicated flow and all other flows exceed indicated flows.

3. Adjust fan speed by changing fan drives or sheaves as necessary.

D. Subsequent testing, adjusting, and balancing:

1. Perform adjustments by adjusting dampers, louvers, or size of orifices or plates.

2. Measure and record air volume discharged at each inlet and outlet and adjust air inlets and outlets to design air volumes within 0 to 5 percent over design rates.

3. Adjust fan speeds and motor drives within drive limitations, for required air volume.

4. Measure air flow and static pressures and adjust air supply and exhaust fan units to deliver at least 100 to 105 percent of the design air volume.

5. Measure and record static air pressure conditions on fans, including filter and coil pressure drops and total pressure across the fan.

6. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.

7. Evaluate space and zone temperature of conditions to determine adequate performance of the systems to maintain temperatures without draft.

8. Permanently mark final balance positions of balancing dampers.

E. Develop heating, ventilating, and air conditioning system schematics similar to Figure 6-1 in SMACNA Testing, Adjusting, and Balancing.

F. Accurately record the required data on AABC, NEBB, or TABB test and balance report forms.

G. Measure amperage draw of fan and pump motors at final balance.

H. Test primary source equipment in accordance with AABC, NEBB, or TABB procedures.

1. Primary source equipment includes items listed in this Section not previously tested as part of this testing, adjusting, and balancing work.

2. Complete appropriate AABC, NEBB, or TABB equipment test forms for each piece of equipment.

3. Calculate cooling and heating capacities to show conformance with specified capacities.

4. Adjust equipment as needed to deliver specified cooling and heating loads.

5. Record final equipment performing characteristics and adjustment settings in the final design report.

I. Testing, adjusting, and balancing acceptance criteria:

1. Procedures successful and complete when heating, ventilating, and air conditioning systems and components are functioning properly and system air flows are within specified tolerances of design flows.

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. The work includes, but is not limited to, the following principal systems and equipment:

1. 120/208-Volt System
2. 480-Volt System
3. Motors
4. Motor Control Centers
5. VFDs
6. Panel boards
7. Low Voltage Switchboards
8. Non-Automatic Transfer Switch
9. Control Panels
10. Conduit and Raceways
11. Transformers
12. Lighting fixtures and lamps
13. Grounding and Lightning Protection
14. Conductors
15. Miscellaneous Controls and Equipment

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

B. Intent:

1. The intent of the contract drawings or PLANS is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.

2. Electrical drawings are generally diagrammatic and show approximate location and extent of work.

3. Install the work complete, including minor details necessary to perform the function indicated.

4. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the ENGINEER in the form of Request for Information (RFI).

5. It is also the intent of these Contract Documents for the Electrical and Package System Contractor, if applicable, to coordinate with each other in

order to provide a complete and workable system with all wiring, conduit and accessories required which may not be shown on the PLANS.

C. Discrepancies:

1. Review pertinent drawings and adjust the work to conditions shown.

2. Where discrepancies occur between PLANS, specifications, and actual field conditions, immediately notify the ENGINEER in writing for interpretation.

3. Dimensions on electrical drawings shall be coordinated with other discipline drawings.

D. Outlet and Equipment Locations:

1. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on other discipline drawings.

2. Review with the OWNER and ENGINEER any proposed changes in outlet or equipment location.

3. Relocation of outlets before installation, up to 10 feet from the position indicated, may be directed by OWNER and ENGINEER without additional cost.

4. Remove and relocate outlets placed in an unsuitable location, when so requested by the OWNER and ENGINEER.

1.03 REFERENCES

A. Perform work, furnish and install materials and equipment in full accordance with the latest issue of applicable rules, regulations, requirements, and specifications of the following:

1. Austin Water (AW) Facility Engineering Standards and Specifications
2. Local laws and ordinances
3. State and Federal Laws
4. National Electrical Code (NEC)
5. State Fire Marshal
6. Underwriters' Laboratories (UL)
7. National Electrical Safety Code (NESC)
8. American National Standards Institute (ANSI)
9. National Electrical Manufacturer's Association (NEMA)
10. National Electrical Contractor's Association (NECA) Standard of Installatiion

11. NFPA 70E Standard for Electrical Safety in the Workplace
12. Institute of Electrical and Electronics Engineers (IEEE)
13. Insulated Cable Engineers Association (ICEA)
14. Occupational Safety and Health Act (OSHA)
15. International Electrical Testing Association (NETA)
16. American Society for Testing and Materials (ASTM)
17. National Fire Protection Association (NFPA)
18. American Concrete Institute (ACI)
19. International Building Code (IBC)
20. Insulated Power Cable Engineers Association (IPCEA)
21. Association Edison Illuminating Company (AEIC)

B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory.

C. Product Quality:

1. All electrical items shall be new and unused. Items such as cables, transformers, motors, control centers, etc., shall be newly manufactured for this project. Proof of purchase documents shall be provided upon request. Utilize products of a single manufacturer for each item.

D. Discrepancies:

1. The PLANS and Specifications are intended to comply with listed codes, ordinances, regulations and standards.

2. Where discrepancies occur, immediately notify the ENGINEER in writing and ask for an interpretation.

3. Should installed materials or workmanship fail to comply, the CONTRACTOR is responsible for correcting the improper installation at no cost to the OWNER.

4. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirement, provide those specified or shown.

E. Permits:

1. Obtain certificates of inspection and other permits required as a part of the work at no cost to the OWNER.

1.04 DEFINITIONS

A. For the purposes of this specification, the word CONTRACTOR specified herein shall pertain to the Electrical and/or Instrumentation and Control

(I&C) Contractor, unless indicated otherwise in this document.

1.05 SYSTEM DESCRIPTION

A. The CONTRACTOR shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under DIVISION 16.

3. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

4. Coordination of Work

   a. It's the responsibility of the General/Prime Contractor to maintain coordination between all trades performing electrical and I&C work.

B. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless otherwise noted. The Electrical Contractor shall be responsible for the proper routing of raceway, subject to the approval of the ENGINEER.

C. Submit to the ENGINEER in writing details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. Submit such request as soon as practicable, but no later than ten (10) days after Notice to Proceed (NTP). Make no such departures without written approval of the ENGINEER.

D. Where the CONTRACTOR is submitting a packaged system, CONTRACTOR shall meet the requirements of DIVISION 16 and DIVISION 17. This includes field cables, conductors, labeling, relays, terminal blocks, conduits, junction boxes, circuit breakers, combination starters, pushbuttons, pilot lights, motors, etc. Deviations shall not be accepted, unless approved in writing in advance. Control centers and special control cabinets wired to terminal blocks shall include the manufacturer's standard quality, unless specifically mentioned to the contrary on the drawings or in the specifications.

E. Maintain continuity of electric service to functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with the OWNER'S designated Representative. Give the OWNER a minimum of 14 days notice prior to any shutdowns. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the ENGINEER. Include costs for temporary wiring and overtime work required in the Contract price. Remove

temporary wiring at the completion of the work. The CONTRACTOR shall be responsible to provide and pay for temporary power to any facility during construction to facilitate the new construction unless prior authorization is approved for use of site power by the OWNER. If a generator is needed, the CONTRACTOR shall be responsible for all associated costs, including fuel.

F. Unless shown in detail, the drawings are diagrammatic and do not necessarily give exact details as to elevations and routing of raceways, nor do they show all offsets and fittings; nevertheless, install the raceway system to conform to the structural and mechanical conditions of the construction.

G. Cabling inside equipment shall be carefully routed, trained, and laced. Placing cables so that they obstruct equipment devices is not acceptable.

1.06 SUBMITTALS

A. Data Required:

1. Submit shop drawings, product data and all other required information as specified in DIVISION 1. Submittals are required on all products and items to be installed on this project.

2. Submittal data must show the manufacturer's name, published ratings or capacity data, detailed equipment drawing for fabricated items, panel diagrams, wiring diagrams, installation instructions and other pertinent data.

3. Where literature is submitted covering a group or series of similar items, the applicable items must be clearly indicated. Mark through items not being provided and clearly identify all options being provided.

4. Do not combine submittals for multiple Specifications Sections.

B. Submittal Items:

1. Submittals are required for all equipment and materials to be used on this project. Submittals shall be complete with all pertinent information and installation details. The CONTRACTOR shall assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals. No installation shall begin until the shop drawings and/or submittals have been approved. In case of correction or rejection, resubmit until such time as they are accepted by the OWNER'S REPRESENTATIVE, and such procedures will not be cause for delay.

C. Terminal Connection Diagrams:

1. Submit terminal connection diagrams for approval prior to any wire

installation.

2. Submit finalized terminal connection diagrams at the end of the Contract.

1.07 QUALITY ASSURANCE

A. All manufacturers named in the contract specifications are a basis as a standard of quality. Substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the ENGINEER and OWNER.

B. An acceptable CONTRACTOR for the work under DIVISION 16, DIVISION 17 and other applicable specifications must have personnel with experience, training, and skill to provide a practical working system. The CONTRACTOR shall have previous water and wastewater experience with at least 5 years in business.

1. The CONTRACTOR shall be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project.

2. The systems must have served satisfactorily for not less than 3 years.

3. The superintendent must have had experience in installing not less than three systems.

4. The CONTRACTOR shall submit qualifications of his firm and resumes of his personnel who will work on this project.

C. All electrical work shall be performed by workers skilled in the electrical trade and licensed for the work by the local authority (Licensed by the State of Texas).

D. A licensed Master Electrician or a licensed Journeyman Electrician holding a current license in the State of Texas shall be required to be on the job site during the performance of any electrical work.

E. All cable splicing and termination methods and materials shall be of the type recommended by the splicing materials manufacturer for the cable to be spliced, and shall be approved by the ENGINEER prior to installation.

F. All materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer, the best practices of the trade, and in conformance with the Contract Documents. The CONTRACTOR shall promptly notify the ENGINEER in writing of any conflict between any requirements of the Contract Documents and manufacturer's directions, and shall obtain written instructions from the ENGINEER before proceeding with the work. Should the CONTRACTOR perform any work that does not comply

with the manufacturer's directions or such written instructions from the ENGINEER, the CONTRACTOR shall bear all costs arising in correcting deficiencies.

G. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the manufacturer's name, trademark, ASME, UL, NEMA and/or other labels in every case where a standard has been established for the particular item. Equipment shall be the latest approved design of a standard product of a manufacturer regularly engaged in the production of the required type of equipment.

H. It is the responsibility of the CONTRACTOR to ensure that items furnished fit the space available with adequate room for proper operation and maintenance. The CONTRACTOR shall make measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that, in the final inspection, will suit the true intent and meaning of the PLANS, Specifications and Contract Documents.

I. The CONTRACTOR shall furnish and install all equipment, accessories, connections and incidental items necessary to complete the work, ready for use and operation by the OWNER.

J. When the ENGINEER and OWNER have reviewed equipment submittals and given instructions to proceed with the installation of items of equipment that require arrangements or connections different from those shown on the drawings, it shall be the responsibility of the CONTRACTOR to install the equipment to operate properly and in accordance with the intent of the PLANS and Specifications, and he shall provide any additional equipment and materials that may be required. All changes shall be made at no increase in the Contract amount.

K. The CONTRACTOR shall support the installation of all equipment, plumb, rigid and true to line. The CONTRACTOR shall determine how equipment, fixtures, conduit, etc., are to be installed, and shall provide foundations, bolts, inserts, stands, hangers, brackets and accessories for proper support whether or not shown on the drawings.

1.08 DELIVERY STORAGE AND HANDLING

A. It is the CONTRACTOR’S responsibility to ensure that the equipment is not damaged. If equipment is damaged upon arrival, it shall be returned to the equipment manufacturer or supplier.

B. The CONTRACTOR shall have a representative on site to receive any and all deliveries.

C. Refer to section 3.09 of this document.

1.09 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

2.02 MATERIALS/CONSTRUCTION

A. Condition: Materials and equipment provided under these Specifications must be new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of equipment specified.

B. NEC and UL: Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products, and issued labels, products used must be listed and labeled by UL.

C. NEMA and IEC: Only NEMA rated equipment is acceptable. IEC or dual rated NEMA/IEC equipment are not acceptable.

D. Factory Finish: Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required.

E. Field Installation: All field installed equipment, conduit, etc., shall require Type 316 stainless steel nuts, bolts, washers, metal framing and supports, and other items as indicated on the PLANS and Specifications.

F. Seismic Design: All electrical equipment to be designed in accordance with/IBC-2006 & ASCE 7-05 code for Seismic Design.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Preparation:

1. At the job site, it the CONTRACTOR'S responsibility to maintain a full-size set of as built drawings that are updated daily.

    a. On the prints, record field changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings.

    b. Mark the drawings with a colored pencil. Record installed feeder conduits, dimensioning the exact location and elevation of the conduit.

2. At the job site, maintain a set of equipment terminal connection

diagrams.

B. Delivery:

1. Deliver as built red line drawings to the ENGINEER in the number and manner specified in DIVISION 1.

3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Cooperation with Other Trades:

1. Coordinate equipment layout in sufficient time to be coordinated with work of others, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

B. Workmanship:

1. Work must be performed by workers skilled in their trade. The installation must be complete whether the work is concealed or exposed as defined by the NEC.

C. Concrete Electrical Equipment Pads:

1. Thickness:

a. Indoor: 4-inch-thick concrete housekeeping pads with chamfered edges or as indicated on the drawings.

b. Outdoor: 6-inch-thick concrete housekeeping pads with chamfered edges or as indicated on the drawings.

2. Place pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond indoor equipment.

3. Exterior pads shall extend one foot beyond the equipment, including cooling fins.

4. Trowel pads smooth and chamfer edges to a 1-inch bevel.

5. Provide dowels in slab, and rebar between the dowels or as designed by the ENGINEER.

6. Housekeeping pads shall be level.

7. Secure equipment to pads as recommended by the manufacturer.

8. Follow structural detail where applicable.

D. Setting of Equipment:

1. Equipment must be leveled and set plumb.

2. All surface mounted Electrical and I&C equipment shall be spaced a minimum 1/4-inch from the mounting surface.

3. Stainless Steel 316 bolts, nuts and washers shall be used to anchor the equipment.

E. Sealing of Equipment:

1. Permanently seal outdoor equipment at the base using concrete grout.

2. Seal or screen openings into equipment to prevent entrance of animals, birds and insects.

3. Use stainless steel mesh with openings not larger than 1/16-inch squares for screened openings.

4. Seal small cracks and openings from the inside with silicone sealing compound.

5. As a minimum, seal all conduits entering a panel with duct seal unless otherwise directed by the ENGINEER or PLANS.

F. Concealed Work: Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:

1. Where shown or specified to be exposed. Exposed is understood to mean open to view.

2. Where exposure is necessary to the proper function.

3. Where size of materials and equipment precludes concealment.

G. Cutting and Patching:

1. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of the ENGINEER. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition.

2. If a CONTRACTOR damages concealed conduits, it is the CONTRACTOR'S

responsibility to make all necessary repairs at no cost to the OWNER.

H. Load Balance:

1. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as closely as possible on switchboards, panel boards, motor control centers, etc.

I. Motor Rotation:

1. Coordinate rotation checks with the ENGINEER and the CONTRACTOR responsible for the driven equipment. Submit a written report to the ENGINEER for each motor verifying that rotation has been checked and corrected.

3.04 REPAIR/RESTORATION

A. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides finish equal to or better than the factory finish, and that meets the requirements of the Specifications and is acceptable to the ENGINEER.

3.05 – 3.06 (NOT USED)

3.07 CLEANING

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps of equipment shall be left on the premises.

B. All temporary wiring, wiring devices and associated equipment shall be removed upon completion of the project.

3.08 TESTING AND INSPECTION

A. Test Conditions:

1. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation.

2. Perform specified tests in the presence of the ENGINEER, as specified in DIVISION 1 and DIVISION 16.

3. Furnish all instruments, wiring, equipment, and personnel required for conducting tests. Engage the services of an independent contractor if

required. Test equipment shall be calibrated within the last 6 months.

4. Demonstrate that the equipment operates in accordance with requirements of the plans and specifications.

5. No process equipment is to be operated until any associated HVAC equipment and auxiliary equipment is operational.

3.09 STORAGE, HANDLING AND PROTECTION

A. Moisture:

1. During construction, provide heaters to protect switchgear, transformers, motors, control equipment, and other items from moisture absorption and corrosion.

2. Apply protection immediately on receiving the products and provide continuous protection.

3. Store all equipment indoors in dry, well ventilated and heated space or as indicated by the ENGINEER/Manufacturer.

B. Clean:

1. Keep products clean by elevating above ground or floor and by using suitable coverings.

C. Damage:

1. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

D. Finish:

1. Protect factory finish from damage during construction operations and until final acceptance of the project.

3.10 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Furnish and install tags/nameplate on all equipment, devices, instruments, J-boxes, Panel boards and conductors marking as indicated on the drawings and specified herein. Major equipment, other than conduit system, shall be furnished with nameplates in accordance with their individual specifications.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. WIRE MARKERS

1. Wire markers shall be as specified in Section 16205 "Wire Tagging"

B. NAMEPLATES

1. Nameplates:

   a. Externally mark electrical equipment by means of suitable nameplates identifying each and the equipment served.

   b. Provide each piece of equipment with a white phenolic nameplate with 3/16-inch high black lettering secured to front of equipment.

   c. Supply blank nameplates for spare units and used spaces.

   d. Actual nameplate legend, which may consist of up to three lines, will be provided to the Engineer on submittals.

2. Nameplate Fasteners: Fasten nameplates to equipment only by means of appropriate 316 SS screws.

   a. Stick-ons or adhesives are not allowed on the outside of a panel.

   b. Machine printed stick-on labels are allowed inside of and/or on the backplane of a panel.

3. Nameplate Information: In general, the following information is to be provided for the types of electrical equipment as listed.

    a. Switchgear, Motor Control Centers, and Distribution Panel boards: On the mains, identify the piece of equipment, the source, and voltage characteristics, i.e., 480V, 3PH, 3W, etc. For each branch circuit protective device, identify the load served and the primary side circuit number.

    b. Transformers: Identify the service source, load served and transformer designation.

    c. Panel boards: Identify the service source, Panel board designation and voltage characteristics.

    d. Motor Starters: Identify the service source, load served, and voltage characteristics.

4. Panel boards:

    a. Prepare a neatly typed circuit directory behind clear heat-resistant plastic for each panel board.

    b. Identify circuits by equipment served and by room numbers, where room numbers exist.

    c. Use equipment names and room numbers selected by the Engineer; names and numbers may be different from those shown on plans.

    d. Indicate spares and spaces with light, erasable pencil markings.

    e. Provide a final set of the panel schedule in the O&M manuals.

    f. Provide a CD with the file for each Panel board to the Owner with the O&M manual.

5. Boxes, Small Equipment, Control Panels:

    a. Pull boxes, J-boxes and similar items shall be marked with Nameplates.

6. Wall Switches: Engrave the switch plate of the switch with the function of the switch.

C. POWER OUTLETS, SWITCHES, AND PILOT DEVICES

1. Mark power outlets with voltage, phase, panel name, and circuit number.

2. Identify all wall switches, disconnect switches, circuit breakers,

automatic/non-automatic transfer switches, etc. with nametags, circuits served, and panel origin, list to be approved by Engineer/Owner.

3. Identify all push-button and control stations stations with their functions and equipment served.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 – 3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Furnish and install nameplates for all Panel boards, motor starters, motor control center cubicles, disconnect switches, instrument panels, dry type transformers and control stations.

B. Engrave the equipment designation, (e.g., "Starter Pump P1"), on nameplates in 3/16-inch black letters on white background of laminated phenolic unless specified otherwise in the equipment section. All switches, indicating lights, pushbuttons, meters and parameter indicators on panels shall be clearly identified with its function or tag, as required. Identification list to be approved by plant personnel through the Engineer.

C. Stainless Steel tags shall be used on instrument, motors and other devices, as applicable. The tags shall be affixed to the instrument with drive pins or stainless steel chain in such a manner that it does not need to be removed to install the instrument. Motors shall carry the tag assigned to its driven equipment.

3.04 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

This section specifies Short Circuit Studies, Protective Device Coordination Studies, Harmonic Studies, Arc Flash Studies and Arc Flash Warning Labels.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced and shall apply as if written here in their entirety. The publications are referred to in the text by basic designation only.

1.	ANSI	American National Standards Institute
2.	IEEE C57.12.00	Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
3.	IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
4.	IEEE 399	Recommended Practice for Industrial and Commercial Power System Analysis
5.	IEEE 1548	Guide for Performing Arc Flash Hazard Calculations
6.	NEMA Z535.4	American National Standard for Product Safety Signs and Labels
7.	NFPA 70	National Electrical Code (NEC)
8.	NFPA 70E	Standard for Electrical Safety in the Workplace
9.	OSHA 29 CFR Part 1910 Subpart S	Electrical

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300.

1. Short Circuit Study

2. Protective Device Coordination Study
   a. Submit within 90 days after approval of Short Circuit Study.
3. Harmonic Study
4. Arc Flash Study
5. Arc Flash Warning Labels

1.07 QUALITY ASSURANCE

A. Short Circuit, Protective Device Coordination, Harmonic and Arc Flash Studies shall be prepared by the manufacturer furnishing the switchboard and other related equipment for incoming service.

1.08 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 – 2.02 (NOT USED)

2.03 FUNCTIONAL REQUIREMENTS

A. Short Circuit Study

1. General:
   a. Prepare in accordance with IEEE 399.
   b. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
   c. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
   d. Use cable and bus resistances calculated at 25 degrees C.
   e. Use medium voltage cable reactance based on use of typical dimensions of shielded cables with 133 percent insulation levels.
   f. Use 600V cable reactance based on use of typical dimensions of XHHW-2 conductors.
   g. Use transformer impedances 92.5 percent of "nominal" impedance based on tolerances specified in IEEE C57.12.00.
2. Provide:
   a. Calculation methods and assumptions
   b. Typical calculation

c. Tabulations of calculated quantities.

d. Results, conclusions, and recommendations

e. Selected base per unit quantities

f. One-line diagrams

g. Source impedance data, including electric utility system and motor fault contribution characteristics

h. Impedance diagrams

i. Zero-sequence impedance diagrams

j. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1) Electric utility's supply termination point

2) Low voltage switchboards

3) Motor control centers

4) Branch circuit panel boards

k. Future load contributions as shown on one-line diagrams

l. Bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

m. Bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.

3. Verify:

a. Equipment and protective devices are applied within their ratings.

b. Adequacy of switchboard bus bars to withstand short circuit stresses.

c. Cable and bus way sizes for ability to withstand short circuit heating, in addition to normal load currents.

4. General Data:

a. Short circuit reactance of rotating machines

b. Cable and conduit material data

c. Bus data

d. Transformer data

e. Circuit resistance and reactance values.

5. Short Circuit Data:

   a. Fault impedances

   b. X to R ratios

   c. Symmetry factors

   d. Motor contributions

   e. Short circuit kVA

   f. Symmetrical and asymmetrical fault currents

6. Equipment Evaluation:

   a. Equipment bus bracing, equipment short circuit rating, transformer, cable, bus way

   b. Maximum fault current available

7. Written Summary:

   a. Scope of studies performed

   b. Explanation of bus and branch numbering system

   c. Prevailing conditions

   d. Selected equipment deficiencies

   e. Results of short circuit study

8. Comments or Suggestions:

   a. Suggest changes and additions to equipment rating and/or characteristics.

   b. Notify OWNER in writing of existing circuit protective devices improperly rated for new fault conditions.

   c. Revise data for "as-installed" condition.

B. Protective Device Coordination Study

1. General:

   a. Prepare in accordance with IEEE 242.

   b. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log

curve sheets.

c. Provide separate curve sheets for phase and ground fault coordination for each scenario.

d. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet.

e. Identify device associated with each curve by manufacturer type, function, and, if applicable, recommended tap, time delay, instantaneous and other settings recommended.

f. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

g. Apply motor protection methods that comply with NFPA 70.

2. Plot Characteristics on Curve Sheets:

a. Electric utility's relays

b. Electric utility's fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands

c. Medium voltage equipment relays

d. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands

e. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands

f. Pertinent transformer full-load currents at 100 percent

g. Transformer magnetizing inrush currents

h. Transformer damage curves; appropriate for system operation and location

i. ANSI transformer withstand parameters

j. Significant symmetrical and asymmetrical fault currents

k. Motor overload relay settings for motors greater than 40 horsepower

l. Ground fault protective device settings

m. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center

3. Primary Protective Device Settings for Delta-Wye Connected Transformer:

    a. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of IEEE C57.12.00 withstand point.

    b. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

    c. Separate medium voltage relay characteristics curves from curves for other devices by at least 0.4 second time margin.

4. Tabulate Recommended Protective Device Settings:

    a. Relays:

        1) Current tap

        2) Time dial

        3) Instantaneous pickup

        4) Electronic settings data file

    b. Circuit Breakers:

        1) Adjustable pickups

        2) Adjustable time-current characteristics

        3) Adjustable time delays

        4) Adjustable instantaneous pickups

        5) I2t In/Out

        6) Zone interlocking

        7) Electronic settings data file

5. Written Summary:

    a. Scope of studies performed

    b. Summary of protective device coordination methodology

    c. Prevailing conditions

    d. Selected equipment deficiencies

e. Results of coordination study

f. Appendix of complete relay and circuit breaker electronic setting files

g. Comments or suggestions

C. Harmonic Study

1. Perform harmonic study for Low-Voltage Adjustable Frequency Drive System.

2. Harmonic study shall include analysis on voltage and current distortion at the PCC to ensure the system complies with IEEE 519.

3. All adjustable frequency drives for the facility shall be considered in the study. Study shall incorporate equipment listed in submittals.

4. Provide results including Total Harmonic Distortion (THD) and Individual Harmonic percentages.

5. Provide comments and/or suggestions based on evaluation.

D. Arc Flash Study

1. Perform arc flash hazard study after short circuit and protective device coordination study has been completed, reviewed and accepted.

2. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

3. Base Calculation: For each major part of the electrical power system, determine the following:

a. Flash hazard protection boundary

b. Limited approach boundary

c. Restricted approach boundary

d. Prohibited approach boundary

e. Incident energy level

f. Personal protection equipment (PPE) hazard/risk category

g. Type of PPE required

4. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.

a. Bus name

b. Bus voltage

5. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:

   a. Bus name

   b. Upstream protective device name, type, and settings

   c. Bus line-to-line voltage

6. Produce arc flash evaluation summary sheet listing the following additional items:

   a. Bus name

   b. Upstream protective device name, type, settings

   c. Bus line to line voltage

   d. Bus bolted fault

   e. Protective device bolted fault current

   f. Arcing fault current

   g. Protective device trip/delay time

   h. Breaker opening time

   i. Solidly grounded column

   j. Equipment type

   k. Gap

   l. Arc flash boundary

   m. Working distance

   n. Incident energy

   o. Required protective fire rated clothing type and class

7. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 8 cal/cm2. Propose approaches to reduce the energy levels.

8. Prepare a report summarizing the arc flash study with conclusions and recommendations which may affect the integrity of electric power distribution system. As a minimum, include the following in the report:

a. Equipment manufacturer's information used to prepare study

b. Assumptions made during study

c. Reduced size copies of one-line drawing; 11 inches by 17 inches maximum

d. Arc flash evaluations summary spreadsheet

e. Bus detail sheets

f. Arc flash warning labels printed in color on adhesive backed labels

2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Adjust relay and protective device settings according to values established by the Protective Device Coordination Study.

B. Make minor modifications to equipment as required to accomplish conformance with the Short Circuit and Protective Device Coordination Studies.

C. Notify ENGINEER in writing of required major equipment modifications.

D. Provide laminated one-line diagrams (full size) to post on interior of electrical room doors.

E. Provide arc flash warning labels on equipment as specified in this section.

3.02 PREPARATION

A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on Drawings.

B. Perform studies using one of the following electrical engineering software packages:

1. SKM Power Tools for Windows

2. ETAP

3. EDSA

C. Perform complete fault calculations for each proposed new service.

D. Utilize proposed and existing load data for the study obtained from Contract Documents provided by the ENGINEER and OWNER.

E. Existing System and Equipment:

1. Extent of the existing system to be included in the study is limited to system elements that affect the new system and equipment.

2. Include fault contribution of existing motors and equipment in the study.

3. Include impedance elements that affect new system and equipment.

4. Include protective devices in series with new equipment.
5. Device coordination time-current curves for low voltage distribution system; include individual protective device time-current characteristics.

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Arc Flash Warning Labels

1. Printed in multi-color on adhesive backed labels. An example label is shown in **FIGURE 1** before the "END OF SECTION" as part of this Section.

3.04 – 3.09 (NOT USED)

3.10 SCHEDULES

A. Initial complete short circuit study shall be submitted and reviewed before the ENGINEER will review Shop Drawings for switchboard and equipment for incoming service.

B. Initial complete protective device coordination and arc flash studies shall be submitted within 90 days after approval of the initial short circuit study.

C. Revised short circuit, protective device coordination, and arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.

D. Final short circuit, protective device coordination, harmonic, and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as installed equipment, materials, and parameter data or settings entered into equipment based on study.

E. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

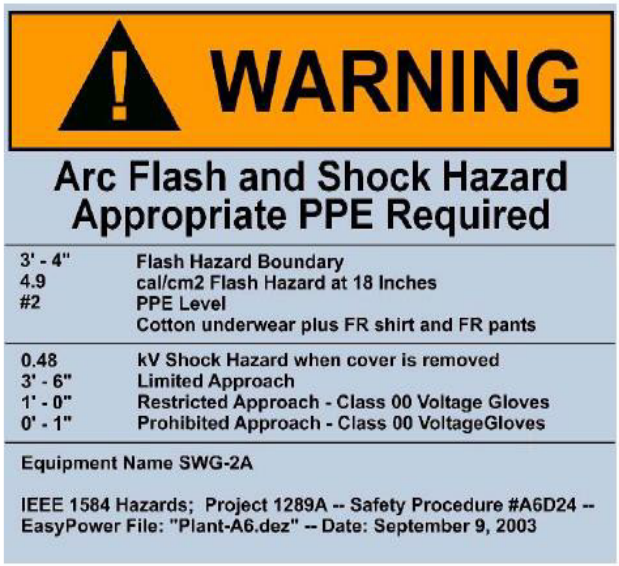


FIGURE 1: Example Arc Flash Label

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Furnish and install necessary materials and make arrangements for the connection of utilities for the project.

B. The required utilities are:
   1. Water service and meter
   2. Electric power service and meter
   3. Telephone line service
   4. DSL

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 – 2.02 (NOT USED)

2.03 FUNCTIONAL REQUIREMENTS

A. The contractor shall coordinate with all required utilities to provide dedicated services.
   1. Costs: All costs associated with the new service shall be covered by contractor.
   2. Transfer: Account shall be transferred to the owner at time of final acceptance of the WORK.
   3. Telephone Characteristics:
      a. Type: voice grade dial up line;
      b. Long distance service and calling services: not to be provided;
      c. Telephone number: unlisted.
      d. Surge protection: to be provided.
   4. Telephone Connection: Contractor shall coordinate with AT&T telephone line company to locate the closest demarcation box and provide all associated cables, conduits and duct banks from demarcation box as shown on the Plans.
      a. Elevator control panels, where required.
      b. Fire alarm panel, where required.

2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Contractor and/or Engineer shall comply with all service installation standards of the serving utility companies.

B. Entrance must be coordinated with the Engineer/Owner. Provide materials and equipment required to connect the project service to the system. Coordinate with Electric Company for requirements of power service.

C. Contractor to follow the mechanical construction schedule, electrical equipment shall be energized on time. Delay to the startup shall not be caused due to Electrical Contractor lack of coordination.

D. Contractor to minimize interruption of service. Contractor to coordinate with Owner prior any interruption per Section 01010.

3.02 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SCOPE OF WORK

A. Furnish labor, materials, equipment, and incidentals necessary to install concrete electrical manholes and pull boxes, as specified, and indicated on the plans. Separate manholes and pull boxes shall be provided for instrument and power duct banks and conduit.

B. Manholes and pull boxes required by the electric utility shall comply with utility standards.

C. Contractor shall be responsible for sizing all manholes and pull boxes in accordance with the National Electrical Code, Article 370, and relevant sections of the NEC. Contractor shall be responsible for setting elevations at manhole and cable entry locations to meet the intent of the specifications and plans. Electrical work shall be in accordance with Section 16010, GENERAL ELECTRICAL REQUIREMENTS.

1.02 QUALIFICATIONS

A. ACCEPTABLE MANUFACTURERS; PRECAST:

1. Precast concrete products shall comply with the specifications and shall be produced by the following Manufacturers:

   a. Brooks Products

   b. American Industrial Precast Products

   c. Dalworth Quickset Co.

B. ACCEPTABLE MANUFACTURERS; CASTINGS:

1. Metal castings shall comply with the specifications and shall be produced by the following Manufacturers:

   a. McKinley Iron Works, Fort Worth, TX

   b. Neenah Foundry, Neenah, WI

C. DESIGN CRITERIA:

1. Concrete for precast concrete shall obtain a compressive strength of 4000 psi minimum at 28 days and shall be an air-entrained mix of the Manufacturer’s standard mix design.

1.03 REFERENCE STANDARDS

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. AASHO H-20:

   a. "Standard Specifications for Highway Bridges"

2. ANSI/ASTM 1-15:

   a. "Zinc Coating (Hot Dipped) on Iron and Steel Hardware"

3. ANSI/ASTM A-569:

   a. "Steel, Sheet and Strip, Carbon (0.15% Maximum), Hot Rolled, Commercial Quality"

4. ASTM A-48:

   a. "Gray Iron Castings"

5. ASTM A-123:

   a. "Zinc (Hot Galvanized) Coatings on Products fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips"

1.04 SUBMITTALS

A. Submittals shall be in accordance with Section 01300, CONTRACTOR'S SUBMITTALS, and shall include:

1. Manholes and pull boxes.

2. Contractor shall provide detailed conduit layout showing number and size of conduits entering the manholes. Cables routed in conduits shall be clearly identified. Details shall also show elevation of conduits entering manholes. Manhole details shall be submitted to the Engineer for approval prior to the duct bank/manhole system being installed.

PART II – PRODUCTS

2.01 MATERIALS

A. MANHOLE FRAMES AND COVERS:

1. Class 30B gray cast iron conforming to ASTM A-48; machine finished with flat bearing surfaces.

B. SUMP COVERS:

1. Class 30B gray cast iron conforming to ASTM A-48.

C. PULL IRONS:
1. Steel bar with 7/8" diameter forming a triangle of 9" per side when set; galvanized according to ANSI/ASTM A-153 for irregularly shaped articles.

D. CABLE RACK INSERTS:

1. Steel channel inserts with a minimum load rating of 800 pounds; length to match cable rack channel.

E. CABLE RACK CHANNELS:

1. 4" x 1-1/2" x 3/16" steel channel wall bracket, 48" long, with cable rack arm mounting slots on 8" centers.

F. CABLE RACKS:

1. 2-1/2" x 14" steel channel with high glazed, wet process porcelain insulators conforming to ANSI/ASTM A-569.

G. MANHOLE STEPS:

1. 2-1/2" x 14" steel channel with high glazed, wet process porcelain insulators conforming to ANSI/ASTM A-569.

H. DUCT TERMINATORS:

1. Duct terminator shall be provided at manhole walls and shall be the product of Formex Manufacturing, Inc., or approved equal. Terminators shall be formed of high impact, high strength, prime virgin acrylonitrile butadiene styrene (ABS) plastic, containing the proper number, size and arrangement of openings to receive ducts installed under this contract. Terminators shall be hollow, 6 inches outside-to-outside of interior and exterior surfaces, to allow placement of reinforcing steel inside. Terminators shall be installed in accordance with the manufacturer’s recommendations. Where terminators are provided only for reception of future ducts, factory-fabricated plastic plugs of proper size shall be furnished and installed in the duct opening.

I. GROUND ROD:

1. 3/4" x 10’ copper clad, installed in the floor of the manhole, and all metallic cable racks, irons, etc. grounded (to the ground rod). Ground rod may be field installed, but floor penetration shall be sealed against the entrance of sewage or clear water under positive head.

J. JOINT SEALANT:

1. Flexible plastic gasket of flexible butyl resin sealant.

2.02 MIXES

A. Concrete and reinforcing shall be in accordance with Section 03300, CAST-IN-PLACE CONCRETE.

2.03 FABRICATION

A. PRECAST CONCRETE:

1. Precast concrete shall be a factory-controlled product, reinforced in accordance with AASHO H 20 bridge loading requirements. Units shall be precast in modular sections with tongue and groove joints. Manholes shall have the following characteristics:

   a. Shape: Square

2. Provide a 36" diameter, grooved opening in the top section. Neck and shaft diameter shall be 30" clear dimension. Provide a 12" drain opening and two (2) 1" ground rod openings in the base section.

3. Include inserts for cable racks at 3” on center. Include precast manhole steps at 16" centers.

PART III - EXECUTION

3.01 PREPARATION

A. Excavate hole for a suitably sized manhole which permits installation and inspection. Base material and backfill shall be in accordance with the Manufacturer's printed instructions and the provisions of Section 02256, AGGREGATE FILL CLASSIFICATIONS, of these specifications.

3.02 INSTALLATION

A. PRECAST CONCRETE:

1. Precast concrete shall be a factory-controlled product, reinforced in accordance with AASHO H 20 bridge loading requirements. Units shall be precast in modular sections with tongue and groove joints. Manholes shall have the following characteristics:

2. Install manholes in accordance with the Manufacturer's printed instructions. Manholes shall be plumb and level. Use precast neck and shaft sections to bring manhole entrance to finished grade 6” above finished grade.

B. MANHOLE ACCESSORIES:

1. Install drains in manholes and connect to 4" PVC pipe terminating in 1/3 cu. yd. of crushed gravel bed.

2. Install a ground rod in each of two (2) base section openings with the top of

the rod protruding 4" above the manhole floor.

3. Attach cable racks to inserts after manhole installation is complete.

4. Waterproof exterior surfaces of manholes, including joints and interruptions after concrete has cured for a minimum of 28 days.

5. Manhole frames, pulling irons and cable rack channels shall be grounded to the ground rods. Grounding shall meet the requirements of Section 16450, GROUNDING, and Articles 250 and 450 of the National Electrical Code.

C. SUPPORTING CABLES ON WALLS:

1. Support cables by cable racks. Provide quantity of racks by the number of conductors routed through manholes. Provide a minimum of two cable hooks per rack.

2. Install a minimum of two racks on each wall in each manhole.

3. Cable racks shall be provided for installation of future conductors.

4. Instrumentation cables, power cables, and control cables shall be kept separately when routed along racks through manholes.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

The following specification together with the drawings and other applicable sections of the specifications comprise the Motor Control Center (MCC). This specification is applicable for lift stations requiring 30-hp motors and above.

1.02 RELATED REQUIREMENTS

Work as called for on PLANS, or in this or other Specification Sections.

A. 01730 O&M Manuals

B. 16140 Wiring Devices

C. 16200 Wires, Conductors and Cables – 600V and Below

D. 16263 120 VAC Uninterruptible Power Supply

E. 16400 Surge Protective Devices

F. 16720 Annunciator

G. 16951 Lift Station Calibration and Testing

1.03 REFERENCES

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

A. The manufacturer of the MCC shall also manufacture the majority of components and subsystems therein (i.e., circuit breakers, starters control relays, etc.).

B. The MCC shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, UL, and NEC standards including, but not limited to:

1. NEMA AB-1 Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
2. NEMA ICS 1-2000 Industrial Control and Systems: General Requirements
3. NEMA ICS 2-2000 Controllers, Contactors and Overload Relays Rated 600V
4. NFPA 70 National Electrical Code (NEC)
5. NFPA 70E Standard for Electrical Safety in the Workplace

6. UL 98 Enclosed and Dead-Front Switches

7. UL 489 Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

8. UL 508 Standard for Industrial Control Equipment

9. UL 845 Motor Control Centers

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300, "Submittals".

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 – 1.09 (NOT USED)

1.10 WARRANTY

A. Manufacturer shall provide a one year warranty from the time manufacturer's start-up services are completed or 18 months from date of shipment whichever is later. Warranty shall include all parts and labor to troubleshoot and replace failed devices.

1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. MCC's shall be Eaton, General Electric, or Square D

2.02 MATERIALS/CONSTRUCTION

A. Structure

a. Each MCC shall consist of the specified number of vertical sections bolted together to form a rigid, self-supporting free-standing assembly. At a minimum NEMA 12 or 3R enclosure or as indicated on the PLANS/ENGINEER. Vertical sections shall be mounted on steel channel sills provided by CONTRACTOR. The structure shall be not more than 90 inches nominal height, and be fabricated of formed steel of not less than 14 gauge thickness. It shall be furnished with removable lifting facilities with a base construction designed for rolling or skidding.

b. Front mounted (dead front) units, where specified, shall not require rear access and shall be suitable for back to wall mounting. All wiring,

bus joints, and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.

c. Each vertical section shall be divided into no more than six compartments which may contain feeder breakers, combination motor control units, or other control assemblies connected to a common vertical power bus.

d. Vertical sections shall contain horizontal wire ways at top and bottom of the structure. The design shall be such to permit a continuous wiring trough from end to end of the entire width of the MCC. End vertical sections shall have cover plates which can be easily removed to allow continuation of wire ways and horizontal bus extensions for future addition of vertical sections.

e. The vertical section shall also have a continuous vertical raceway extending the full height of the structure and shall intersect with the horizontal raceways. This wire way shall be completely shielded from the bus compartments, the controller compartment, and the adjacent vertical units, and shall have its own separate hinged door or bolted cover.

f. Holes or slots provided in wire ways or other metal members for routing of wires shall be designed to avoid damage to the wiring insulation.

g. Combination motor control units (size 5 and smaller), as well as other electrical assemblies, including feeder tap units (225 amp and smaller), shall be provided with appropriately rated stab assemblies for draw out (plug-in) type construction.

h. Plug in provisions shall include a positive guide rail system to insure alignment of stabs with the vertical bus. The stab shall be designed to increase bus contact pressure during a fault. The stab design shall assure a consistent low-resistance contact with the vertical bus, even after repeated insertions and removals. The unit shall be equipped with a latching mechanism to lock the drawer in an extended or stabbed position for maintenance and testing. Each draw out compartment is to have a separate hinged door.

i. Each unit compartment shall be provided with an individual front hinged door. Motor control and feeder units shall be interlocked mechanically with a unit disconnect device to prevent unintentional opening of the door while unit is energized. An interlock between the unit disconnect and the structure shall prevent the removal or reinsertion of the unit when the unit is in the "OFF" position. Means shall be provided for releasing the interlock for intentional access and/or application of power. Pad locking arrangements shall permit locking the disconnect device in the "OFF" position.

j. Each vertical section including control panel section shall have at least one 120 volt, 250 watt space heater thermostatically controlled and wired to panel board in MCC.

k. The MCC shall be furnished as a complete factory assembled unit where transportation facilities and installation requirements permit. Minimize shipping splits if required.

l. All painted steel work shall be treated with a primer coat and finished with a coat of baked enamel at the factory, such that no field painting will be required except for "touching up" of damaged areas. Color shall be manufacturer's ANSI 61 light gray.

m. Furnish documentation with the equipment as follows: Compartments containing panel boards shall have a card holder on the inside of the door with the branch circuits clearly identified. Compartments containing motor starters shall each have an overload heater section table posted inside the door. All control compartments shall have a pocket on the inside of the door with a copy of the appropriate schematic and wiring diagram.

n. Provide screw on type engraved laminated nameplates as follows: Main equipment nameplate shall be located at the top of the MCC near the main breaker compartment. Individual compartment nameplates screwed to their respective doors. Control device nameplates for all devices screwed on near the vicinity of each device as approved by the ENGINEER. And a manufacturer's plaque shall be attached to the MCC giving model number, bus amps, voltage, maintenance reference documents, and other applicable information.

o. The structure shall have the number of sections as shown on the drawings. A control section shall be provided for pump controls, flow monitoring, etc. This section shall have a full size white baked enamel back panel to mount components on. This section shall be a minimum of 36" wide.

B. Buses

a. All buses shall be tin plated copper. The main horizontal bus shall extend the entire length of the MCC. The main bus bars shall be rated as shown on the drawings, but shall not be less than 600 amperes.

b. Each vertical draw out section shall have a full height vertical tin plated copper bus rated as specified, but not less than 300 amperes. Each vertical bus shall be of uniform cross sectional area from top to bottom. Tapered bus will not be acceptable. The bus support system shall be high dielectric strength, low moisture absorbing, high impact material.

c. A continuous tin plated copper ground bus shall be furnished for the entire length of the MCC. Provide ground bolted connectors for 2/0 AWG wire at each end of the bus.

d. Bus bracing shall be 42,000 amperes RMS, symmetrical unless otherwise indicated on the attached data sheets or contract drawings.

e. All buses, except ground buses, shall be completely concealed by steel plates or insulating material. Cutouts shall be provided in the vertical isolation barriers for stab connections to vertical bus. Unused cutouts shall be covered.

f. All bolted bus mating surfaces shall be tin plated copper.

g. Buses used for the tie circuit breaker or the tie feeder lugs between MCC's where specified, shall be rated for a continuous capacity equivalent to the main horizontal bus rating.

C. Wiring

a. Unless otherwise stated in the data sheets, the MCC shall be wired Class II, type B construction with master terminal blocks for each cubicle.

b. All wiring shall be MTW/SIS tinned stranded copper not smaller than #14.

c. All control wiring to draw out units shall be run through split type terminal blocks (draw out) which can be split to allow easy unit removal. Motor "T" leads will bolt directly to starter or overloads and will not be split type.

d. All wiring shall be neatly bundled with cable ties or spiral wrap and supported to wire way supports. Control wiring shall be bundled separately from power wiring. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

e. One spare normally open and one normally closed contact on all relays, selector switches, push buttons, "m" contact, alarm points, etc. shall be wired to terminal blocks.

f. Where "shipping splits" are required between the control compartments and the starter cubicles, interconnecting jumper wires shall be provided for field re-connection.

D. Identification

a. All component and control identification phenolic nameplates shall be engraved with the device name and number exactly as it appears on the MCC One Line Drawing and/or as approved by the ENGINEER. For devices not shown on the One Line Drawing such as time delay relays, the names will be as shown on the Control Schematic Drawings and/or as assigned by the ENGINEER. All nameplates shall be attached to the backplane.

b. All wiring shall be tagged and coded with an identification number as shown on drawings. Coding will be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire.

The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS or equivalent by Panduit.

c. All terminal blocks shall be identified by a system approved by the ENGINEER.

E. Components

a. Provide transient voltage surge protection on each incoming line.

b. On incoming line circuit breakers of 1000 amps or more, provide ground fault protection (relay) complete with CT's and local indication that a ground fault has occurred (or solid state breaker trip unit with indication).

c. Provide a microprocessor based solid state power metering device for each incoming line with the following minimum features:

a. Volts and amps each phase

b. Power reading in KW

c. Consumption in KWH

d. Power factor

e. Frequency

f. VARs

g. Monitor shall be field configurable by jumpers dip switches, etc. or configurable from face of unit.

h. Relay contact output configurable for loss of power.

i. PQM II Power Quality Meter or equal as manufactured by the gear manufacturer.

d. Each incoming line section shall have a solid state voltage monitor device (unless otherwise noted) with features as specified on drawings and specifications, but as a minimum, with the following features.

a. Phase loss, phase unbalance, phase reversal

b. Over voltage and under voltage

e. Protective device is to have field adjustable trip levels and time delays for phase unbalance, and over voltage and under voltage conditions. Provide spare set of auxiliary contacts for interlocking and remote alarming. Protective relays to have a device to identify cause for trip. Device must indicate even if power is lost. Protective features may be built into power metering unit defined in Section 2.02.E.3.

f. On double ended or main – tie - tie - main MCC line-ups, a Kirk Key interlock systems shall be furnished to prevent parallel operation of incoming lines.

g. Furnish lugs for incoming line feeders as required. Allow adequate clearance for bending and terminating of cable type specified.

h. Furnish adjustable thermostat.

i. Starters

   a. Type - Starters shall be Size 1 minimum. Furnish full size NEMA starters. IEC units and half-size units are not acceptable.

      1) NEMA starter sizes 1 through 4

         a) Furnish and install combination type non-reversing full voltage magnetic starters rated per the power voltage service and applicable fault current rating. Starter shall be equipped with solid state overload protection. Overload protective functions include phase loss, phase unbalance, selectable trip class, automatic/normal reset and ground fault protection. Starter shall be equipped with a display module which displays A, B, and C phase currents trip reset and a display of all trip functions listed above. If solid state overload requires DC control power, provide a power supply per starter. Multiple starters on one power supply will not be accepted.

         b) Furnish and install smart motor monitoring overloads and relays. Motor monitoring overloads and relays shall be capable of monitoring phase loss, phase reversal, over current, over voltage, and under voltage at a minimum. Type shall be Eaton C441CA or C441CB, Schneider Electric TeSys T LTM R Modbus Motor Management Controller. Motor monitoring overloads and relays shall include a door mounted display. Provided models shall support Modbus TCP (using Ethernet protocol/cabling). The Ethernet modules for Eaton relays C441CA and C441CB are model numbers C441R (120 VAC inputs and outputs) and C441T (24 VDC inputs and outputs). The Ethernet modules for the Schneider Electric TeSys T LTM R Modbus Motor Management Controllers are model numbers LTMEV40M (120 VAC inputs) and LTMEV40BD (24 VDC inputs).

   b. Protective devices in motor starters

      1) Where required by PLANS, motor starters shall be provided with a GE-Multilin SR 469 digital motor management relay. The relay shall incorporate the following functions and features:

a) Protecting Functions

I. Overload - Stator thermal protection model shall combine inputs from positive and negative sequence currents and RTD winding feedback to provide dynamic following of motor loading and temperature rise,

II. Stall - For additional protection of the rotor during stall and acceleration, the relay shall:

i. Use voltage compensation of the stall/acceleration curve

ii. Have a speed switch input available

iii. Jam

iv. Negative sequence unbalance/single phase

v. 12 RTD inputs, field programmable as to RTD type

vi. Ground overcurrent

vii. Short Circuit

2) Differential protection using inputs from either:

a) 3 CTs on each side of machine winding

b) 3 window type CTs with both the line and neutral leads of the motor brought through the CTs

c) Capability to create a custom overload curve for increased protection of difficult starting/running motor protection applications

3) Additional functions provided from voltage transformer inputs shall include:

a) Over voltage

b) Under voltage

c) Phase reversal

d) Over frequency

e) Under frequency

4) The relay shall include a complete onboard power metering package capable of displaying:

a) Average and individual phase currents

b) RTD temperatures (hottest, individual, maximum)

c) Unbalance ratio (%In/Ip)

d) Ground leakage current

e) Thermal capacity remaining/estimated time to trip at present overload level

f) Motor load as a percent of full load

g) Phase to phase or phase to neutral voltage

h) W, VAR, KWH, PF, Hz

i) The relay shall be of draw out construction to facilitate ease of testing, maintenance and replacement

5) The digital relay shall have the following user interfaces:

a) Integrated keypad to access actual values and set points

b) 2 - line, 40 character illuminated vacuum fluorescent display for use with keypad

6) The relay shall have:

a) Variable scrolling rates

b) Front mounted LEDs to display alarms, trips, and relay status

c) Relay reset button and LED to indicate when the relay may be reset

7) Communications with the digital relay shall be accomplished by:

a) Ethernet module with Modbus TCP IP

8) Set point programming shall be available through a front mounted RS232 interface.

9) Interface software shall be in a Windows format.

10) The relay shall have 9 discrete opto-isolated digital inputs and 4 4-20mA analog inputs

11) The relay shall have 6 output relays with Form C contacts and 4 assignable 4-20mA analog outputs.

12) Relay output shall be through alarm and trip functions.

13) Relay memory shall store the last 40 events.

14) Control Power – The relay shall be suitable for:

a) HI Range of available control power:

I. DC: 88-300 Vdc

II. AC: 70-265 Vac, 48-62 Hz

15) Switching the RVAT from the 65% tap voltage to the 100% tap voltage will be controlled by the Multilin SR469.

a. Overloads shall be capable of being reset with a push button mounted on the enclosure swing out panel.

b. Adjust overload protection and verify that protection corresponds to motor full load current and that motors will start and operate properly.

c. At 75 Hp and larger, motor starter shall be reduced voltage starting. Standard reduced voltage starter shall be autotransformer type (RVAT), non-reversing starter.

d. MCC shall have a lighting transformer and panel board in one section or as designed by the ENGINEER. Transformer shall be a single phase, 10KVA, 120/240 volt secondary with a 115 degree Celsius temperature rise or as shown on the PLANS.

e. The MCC Panel Board shall be 120/240V single phase with tin plated bus and a minimum of 20 bolt on circuit breakers.

1) Circuit breakers to be one inch wide and rated as shown on the drawings.

f. Control power transformers shall be 120 volt grounded secondary. One leg of the secondary transformer shall be solidly grounded while the other leg shall be equipped with a slow acting fuse. The transformer shall be oversized for auxiliary loads as indicated on drawings, but in no case be smaller than 100 VA. Primary side of the transformer shall be fused.

F. Thermal Magnetic Circuit Breakers

a. All branch feeder or main/tie circuit breakers shall be of the thermal magnetic trip type.

b. Main and Tie circuit breakers shall be electrically operated type.

c. Main breakers shall have a normally open auxiliary contact wired to terminal block to provide breaker status information.

d. Circuit breakers shall be draw out (plug-in) type, molded case, 600 volt. All circuit breakers with 225 ampere frames and larger shall have

interchangeable trips units. Breakers shall have fixed thermal and adjustable magnetic trips.

e. Furnish 75 degree C rated lugs for terminating cable to starters and circuit breakers, sizes as specified on drawings and related data sheets. Allow adequate clearance for bending and terminating of cable type specified.

G. Control Panel Section

a. Pilot Lights

a. Pilot lights shall be Light Emitting Diode (LED) NEMA 4 full size, 30 mm, oil tight, and push to test, with legend plate marked as shown on the drawings. Pilot lights shall be LED type, Square D SKT38L or equal.

b. Elapsed Time Meters

a. Running time meters shall be approximately 3-1/2-inch square non-reset, 99,999.9 hour range; type 236 as manufactured by General Electric CO., or equal. Run time meters shall also be driven directly from a starter contact.

c. Control Relays

a. Control relays shall have 120V coils, 11 pin tubular octal bases with indicating lights and contacts rated for 10 amps. Furnish 1 N.O. and 1 N.C. spare contacts in addition to those required by the control scheme.

d. Timing Relays

a. Timing relays shall have 120 volt coils, 11 pin base, selectable for on delay or off delay functions, and settable for time delays of 0.05 seconds to 999 minutes with 10 amp contact rating. Relays shall be Square D class 9050 type JCK70 or equal.

e. Selector Switches

a. Selector switch shall be 30 mm fully guarded NEMA 4 with manual return.

f. Push Buttons

a. Push buttons shall be 30 mm fully guarded NEMA 4.

g. Digital Indicator/Controller

a. In accordance with Section 16942.

h. Terminal Blocks

a. Terminal blocks shall be 600 volt rated, rail mounted capable of accepting #22 to #8 wires. Terminal blocks shall be Allen Bradley 1492 Series rated for a minimum of 25 amps or equal.

i. Fuse Blocks

a. Fuse blocks to be the number of poles as shown on drawings, rated for 300 volts minimum. Fuse blocks shall be Square D Type FB.

j. Light Switches and Receptacles

a. In accordance with Section 16140.

k. Motor Moisture Sensors and Temperature Sensors (where shown on the PLANS)

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

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

c. Motor OT sensory shall be wired to provide motor shutdown and alarm. Motor moisture sensory shall be wired to provide alarm. See the pump control panel schematic design drawings.

l. Alarm Horn and Beacon

a. Alarm horn and red flashing beacon shall operate on 120 VAC and be rated for outside use. Horn shall have adjustable loudness control. Alarm horn and beacon shall be separately controlled.

m. Interior Light

a. Control panel shall contain a 120 volt LED light with an automatic door switch with a manual override switch.

n. Panel Wiring

a. All control wiring to be flexible 41 strand #14 AWG, 600 volt insulation type SIS, color coded as outlined in wiring specification.

2.03 FUNCTIONAL REQUIREMENTS

A. The following minimum tests and checks shall be made before energizing the MCC. These tests shall be performed by a Factory Trained Field Technician specializing in power distribution equipment installation and repair.

   a. Thoroughly inspect MCC for items such as loose connections, presence of foreign material and remedy prior to energizing.

   b. Check all mechanical interlocks for proper operation.

   c. Set protective relays according to settings provided by MCC supplier and verify proper operation.

      a. The settings should be based on the Coordination Study for the project.

   d. Megger terminals and buses for grounds after disconnecting devices sensitive to Megger voltage.

   e. Verify continuity of ground bus throughout MCC.

   f. Verify heater circuits are operational.

   g. Verify ratios of all CT's, and proper operation of all metering.

   h. Submit documentation of all test outlined above to the OWNER for review and acceptance. Additionally, include all data in Operation and Maintenance (O&M) manuals.

   i. Start-up procedures to be in accordance with Section 16951 as applicable.

2.04 TOOLS, SPARE PARTS AND ACCESSORIES

E. Furnish the following spare parts with the equipment for each MCC in conformance with the specifications:

   a. Digital Controller/ Indicator

   b. Starter (1 for each size used)

   c. Fuses (box of 10 for each size used)

   d. Five control relays

   e. Three timing relays

   f. Two complete pilot lights

   g. Five spare LED bulbs of each color used

   h. Pump moisture sensor (1 for each operating pump)

i. Pump temperature sensor (1 for each operating pump)

j. Starter metering module that mounts in door (1 for each motor starter)

k. One solid state overload block

l. One handheld overload programming terminal for overload blocks

m. One DC power supply for solid state overload (if required)

n. Two spare push buttons, selector switches, indication light assembles for each.

o. One breaker test unit if breakers are equipped with solid state trip units.

p. One spare microprocessor based solid state power meter.

q. One spare solid state voltage monitor device.

r. Provide any software required to program starters, breakers, trip units, etc.

PART III - EXECUTION

3.01 GENERAL

I. For additional construction notes and special requirements, refer to the MCC drawings. MCC Control Section may be wired by an original equipment manufacturer (OEM). One set of drawings shall show the entire system including all pump controls.

3.02 – 3.03 (NOT USED)

3.04 REPAIR/RESTORATION

A. Clean and vacuum all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

C. After all connections have been made, the CONTRACTOR shall spray all terminals, terminal blocks, starters (with contacts closed) with a clear spray provided by CMC, Dow Chemical Corporation or approved equal.

D. Notify the ENGINEER 24 hours prior to his intent to spray each MCC. If no such notification is made it will be presumed that moisture proofing has not been accomplished.

E. Remove all current transformer shunts after completing secondary circuit.

F. Verify proper phase rotation of all loads including utility and generator.

3.05 – 3.07 (NOT USED)

3.08 TESTING AND INSPECTION

A. Factory Inspection and Tests

1. The MCC shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

2. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

3. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the ENGINEER'S approval.

3.09 STORAGE, HANDLING AND PROTECTION

A. The CONTRACTOR and MCC supplier shall be responsible for safety of the MCC during storage, transporting and handling.

B. At all times the MCC shall be housed inside a moisture free weatherproof housing.

C. The MCC shall have weatherproof non-porous extra heavy duty plastic covers at all times, until it is ready for test and start-up.

D. Interior and exterior of the MCC shall be kept clean at all times.

E. Space heaters within the MCC shall be energized during storage and installation.

3.10 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Furnish and install all cabinets, junction boxes, pull boxes and outlet boxes as shown on the drawings, required by the specifications or NEC, or as otherwise necessary for a satisfactory operating system.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced and shall apply as if written here in their entirety. The publications are referred to in the text by basic designation only.

1. NFPA 70 National Electrical Code (NEC)
2. ANSI 514 Electrical Outlet Boxes and fittings
3. ANSI OS 1 Cast Aluminum Outlet Boxes, Device Boxes, Covers and Box Supports, and Steel Covers.

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300.

B. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

C. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. JUNCTION AND PULL BOXES

1. Junction box shall be NEMA 4X constructed of 316 stainless steel. Junction boxes 12" X 12" X 6" and smaller, may be manufactured of aluminum. All splices to be connected to terminal blocks inside junction box. Covers shall be hinged and latches shall be a quarter turn screw. Box to be a Hoffman Concept Series, Rittal Corporation, Saginaw or equal.
2. Where junction boxes are located within Class I Div II Areas, the junction box shall be NEMA 7, explosion proof.
3. Junction boxes mounted flush in the wall are to be galvanized metal boxes rated for exposure to material it comes in contact with.
4. Provide boxes conforming to NEC Article 314.
5. Listing: UL 514.

B. RECEPTACLES AND LIGHT SWITCH BOXES

1. All outlet and switch boxes installed outdoor and indoor to be of one piece. All boxes to be provided with covers of the same manufacture as the boxes. The type of cover selected must meet the conditions imposed in every case or as indicated by Engineer. Outdoor receptacle covers shall be While-In-Use Covers per NEC.
2. Boxes shall be sand-cast aluminum, 100% copper-free. Boxes to be manufactured by Crouse-Hinds, Appleton, or approved equal, type FS-SA and FD-SA, with above options and accessories.
3. Masonry boxes
    a. Provide stamp metal masonry boxes,
    b. Use boxes with 1-gang capacity in excess of the number of devices to be installed,
    c. Extension ring covers shall not be acceptable.
4. Listing: UL 514.

C. TERMINATION CABINETS & BOXES

1. Termination cabinets shall be NEMA 4X 316 stainless steel gasketed. Cabinets shall be of sufficient size to adequately contain all terminals, wire-duct, and cables as determined by the CONTRACTOR. Cabinets shall have removable doors (lift-off) not more than 30-inches wide, and shall be equipped with a three point locking latch handle.
2. Wire terminal blocks shall be Square D Type M Barrier Block system, or equal.

a. M4/6G or B 22014 AWG 6 MM (.234 inch) wide, Grey, Blue, Single Level, 600 volt, 25 amp.

b. M6-8G or B 22-8AWG 8MM (.315 inch) wide, Grey Blue, Single Level, 600 volt, 55 amp.

3. The wire terminal block system shall be for DIN rail mounting, and shall include fuse/switch blocks, circuit breaker block, and isolation switches.

D. Acceptable Manufacturers:

1. Hoffman, or approved equal.

2.03 -2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL (NOT USED)

3.02 PREPARATION

A. Coordinate location of all boxes with all other work.

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Junction and Pull boxes:

1. Set junction and pull boxes square and true with building surfaces. Secure boxes firmly to 316 Stainless Steel strut support channels.

2. Install boxes as required to facilitate cable installation in raceway systems.

3. Generally provide boxes in conduit runs of more than 100 feet.

4. Locate boxes strategically and make them of such shape and size to permit easy pulling of wire or cables. Size boxes in accordance to NEC Article 314.28 requirements.

B. Outlet Boxes

1. Flush Boxes:

a. Unless otherwise indicated, mount all outlet boxes flush within 1/4-inch of the finished wall or ceiling line

b. Securely fasten outlet boxes in position using clips or other suitable means.

2. Mounting Height:

a. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate.

1) Switches shall be mounted at 50-inches

2) Receptacles shall be mounted at 36-inches

3) Remove and relocate any outlet box placed in an unsuitable location.

b. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation.

c. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall.

d. Verify the final location of each outlet with Engineer before rough-in.

3. Box Openings:

a. Provide only the conduit openings necessary to accommodate the conduits at the individual location.

3.04 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Furnish and install all necessary wiring devices at the locations indicated on the Plans and elsewhere as required.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300, "Submittals".

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. LIGHT SWITCHES

1. Specification grade, 20 amp, 120/277 volts. Hubbell 1221-I through 1224-I (single pole through four-way respectively). Ivory operating handle: Equals by Bryant, General Electric, Pass and Seymour are acceptable.

2. Switch cover plates shall be Die Cast Aluminum, 99% copper-free, "Crouse Hinds" DS185, or approved equal, or as indicated on the Plans.

3. Mount in boxes as specified in Section 16130.

4. All mounting hardware is to be 316 stainless steel.

B. RECEPTACLES

1. Standard:

a. Hubbell No. 5362-I, or approved equal by Bryant, General Electric, Pass and Seymour. Duplex, 3-wire, polarized grounding type, rated 20 amp, 125 volt, 60 Hertz.

2. Ground Fault:

a. Weather resistant, Hubbell No. GFTR20IU, or approved equal by Bryant, General Electric, Pass and Seymour.

3. Mount in boxes as specified in Section 16130.

C. RECEPTACLE COVERS

1. Outdoor receptacle covers shall be While-In-Use covers per NEC.

2. Indoor receptacle cover plates shall be Die Cast Aluminum, 99% copper-free, manufactured by "Crouse-Hinds" WLRS (single cover) and WLRD (duplex cover), or approved equal.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

3.02 PREPARATION

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. INSTALLATION

1. Switch and receptacle elevations shall be as indicated in Section 16130.

2. Indoor and outdoor boxes shall be grounded per Section 16550 Grounding.

3.04 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

This section specifies raceways, fittings, and supports for all cables, conductors and electrical equipment. The CONTRACTOR shall furnish and install complete raceway systems in accordance with the following specifications.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced and shall apply as if written here in their entirety. The publications are referred to in the text by basic designation only.

1. ANSI C80.1 Electric Rigid Steel Conduit
2. ANSI C80.5 Electrical Rigid Aluminum Conduit
3. ETL-PVC-001 Edison Testing Lab Polyvinyl Chloride
4. NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)
5. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
6. NEMA TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
7. NEMA TC 14 Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
8. NFPA 70 National Electrical Code (NEC)
9. UL 651 Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
10. UL 2515 AG Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
11. UL 2420 BG Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
12. UL7 514B Conduit, Tubing, and Cable Fittings

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300.

1.07 – 1.10 (NOT USED)

1.11 OPERATION AND MAINTENANCE MANUALS

A. Operations and Maintenance (O&M) Manuals are not required for materials covered under this Section.

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. Exposed-Outdoor and Non-Chemical Areas Above Ground Level

1. Rigid Aluminum Metal Conduit System

   a. Conduit run above ground shall be U.L. listed 99% copper free rigid aluminum and meet the requirements of ANSI C80.5. Conduit pipe straps and hardware to be 316 stainless steel. Conduit shall be manufactured by Allied Company, or approved equal.

   b. Minimum above grade conduit size for all work shall be 3/4-inch.

2. Conduit Seals

   a. Conduit seals to be suitable for use in class-I, group B, C, and D, and class-II group F and G. Conduit seals shall also meet or exceed the following minimum requirements:

   b. Seal body, nipples and closures shall be 99% copper-free aluminum. Seal bodies shall be filled with 3M 2123 Re-Enterable Sealing Compound.

      1) Class 1, Division 1 areas shall be sealed per NEC requirements.

   c. Drain: Stainless steel

   d. Removable Nipples: 99% copper-free aluminum

   e. Conduit seals to be manufactured by Crouse-Hinds type EYS drain seals with specified options, or approved equal.

   f. Seals to be installed directly adjacent to, and, just immediately before entering wet well junction box. See details on drawings.

3. Conduit Hubs

    a. Conduit hubs shall be the grounding type, 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by Myers, or approved equal. Conduit hubs shall be furnished complete with rubber gasket.

4. Grounding Bushings

    a. Conduit grounding bushing shall be 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by Meyers type STAG, or approved equal.

5. Conduit Bodies

    a. All conduit bodies shall be 99% copper-free aluminum. Conduit bodies shall be manufactured by Crouse-Hinds Form 7, or approved equal.

6. Conduit Body Covers

    a. Conduit Body Covers shall be die cast aluminum with 316 stainless steel screws. Snap on covers are unacceptable. Supply separate gaskets with all covers.

7. Conduit Unions

    a. Conduit unions shall be threaded, 99% copper-free aluminum. Conduit unions shall be manufactured by Crouse-Hinds type UNF or UNY, or approved equal by Appleton or O.Z. Gedney.

8. Clamp Backs

    a. Single runs of conduit may be supported with cast aluminum clamp backs with stainless steel hardware and standoffs.

9. Conduit Straps

    a. All conduit straps shall be 316 Stainless Steel unless indicated differently by the plans and or specifications.

10. Liquid Tight Flexible Conduit

    a. Liquid tight flexible conduit shall be non-metallic (NM) type liquid tight flex for sizes ¾" through 2". For sizes 2 ½" and larger provide standard seal tight flex with aluminum core, formed from PVC plastic. Provide aluminum or nonmetallic liquid tight fittings that are suitable for installation in temperature range between -20 degrees C to +60 degrees C (suitable for use outdoors and indoors). Liquid tight flexible conduit and fittings shall be as manufactured by "Electri-Flex" series NM type B-PVC, Thomas &

Betts type LT-38P, or approved equal. ½" type NM flexible liquid tight conduit may be used for instruments having ½" threaded entry point.

b. Liquid tight flexible conduit shall be used for connections to motors, field instruments, etc., and any equipment subject to vibration, and, where shown on the drawings. Maximum length **to be 36" unless** otherwise noted on drawings or approved by the OWNER or ENGINEER.

11. Electrical Equipment and Raceways Support Channels

a. Electrical equipment and raceway support channels shall be fabricated with 316 stainless steel material manufactured by Unistrut Corporation series P-1000SS and P-1001SS, or approved equal. All fastening hardware, fittings, supports, base posts, clamps, framing system, etc. shall also be fabricated with 316 stainless steel. Manufacturer shall be Unistrut Corporation, or approved equal.

B. Exposed Chemical Areas

1. Schedule 80 PVC

a. Conduit shall be Schedule 80 PVC, U.L. rated, No. 651, conforming to NEMA standard TC-2 and listed in conformity with Article 352 of the National Electrical Code (NEC). The conduit is to be manufactured by Carlon, or approved equal. Solvent weld shall be a type approved by the conduit manufacturer.

b. Minimum above grade conduit size for all work shall be 3/4-inch.

2. Conduit Hubs

a. Conduit hubs shall be manufactured from fiberglass as manufactured by Champion, or approved equal. Conduit hubs shall be furnished complete with rubber gasket.

3. Conduit Bodies

a. All conduit bodies shall be manufactured from PVC.

4. Conduit Body Covers

a. Conduit Body Covers shall be PVC with 316 stainless steel screws. Conduit body covers shall be furnished complete with rubber gasket.

5. Clamp Backs

a. Single runs of conduit may be supported with PVC or fiberglass clamp backs and standoffs with fiberglass hardware.

6. Conduit Straps

    a. All conduit straps shall be fiberglass or PVC, unless indicated differently by the plans and or specifications.

7. Liquid Tight Flexible Conduit

    a. Liquid tight flexible conduit shall be non-metallic (NM) type liquid tight flex for sizes ¾" through 2". For sizes 2 ½" and larger provide standard seal tight flex with aluminum core, formed from PVC plastic. Provide aluminum or nonmetallic liquid tight fittings that are suitable for installation in temperature range between -20 degrees C to +60 degrees C (suitable for use outdoors and indoors). Liquid tight flexible conduit and fittings shall be as manufactured by Electri-Flex series NM type B-PVC, Thomas & Betts type LT-38P, or approved equal. ½" type NM flexible liquid tight conduit may be used for instruments having ½" threaded entry point.

    b. Liquid tight flexible conduit shall be used for connections to motors, field instruments, etc., and any equipment subject to vibration, and, where shown on the drawings. Maximum length **to be 36" unless** otherwise noted on drawings or approved by the OWNER or ENGINEER.

8. Supporting Hardware and Brackets

    a. All support channels shall be manufactured from fiberglass.

    b. All fastening hardware shall be suitable for chemical area, or as approved by the ENGINEER/OWNER.

C. Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete

1. Schedule 40 PVC

    a. Conduit run underground in duct bank system shall be Schedule 40 PVC, U.L. rated No. 651, conforming to NEMA standard TC-2 and listed in conformity with Article 352 of the National Electrical Code (NEC). The conduit is to be manufactured by Carlon, or approved equal. Solvent weld shall be a type approved by the conduit manufacturer.

    b. Minimum conduit size for all underground work shall be 1-inch.

2. PVC Coated Galvanized Rigid Steel Conduit

    a. PVC coated RGS conduit shall be coated with a 40 mil exterior coating of PVC and a 2 mil urethane interior coating. The coating system shall be in compliance with ETL PVC-001. Refer to Part 3-

Execution of this Section, and to details provided on the contract drawings. PVC Coated Rigid Galvanized Steel conduit shall be Plasti-Bond REDH2OT or Perma-Cote coated conduit as manufactured by Rob Roy. A manufacturer's installer certification shall be required for electricians installing the PVC coated RGS conduits.

b. Minimum conduit size for all underground work shall be 1-inch.

3. Reinforced Thermosetting Resin Conduit (RTRC)

a. RTRC shall be Champion HAZ DUCT XW Type fiberglass conduit or equivalent.

b. The use of RTRC shall conform to Article 355 of the National Electric Code (NEC).

c. Installation of conduit, including field bends, shall be done so ONLY in accordance with the manufacturer's installation instructions.

d. Fittings

1) 90 degree bends with factory installed 2 deep socket PVC coupling and 1 fiberglass coupling bonded to elbow

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-90-2DF**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-90-2DF**

2) Sleeve Couplings

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-42**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-42**

3) Female Terminal Adapters

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-32**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-32**

4) Straight Socket Conduit

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-10S**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-20-S**

e. Champion Mix Epoxy Adhesive

1) For ambient temperatures 40 - 70 degree F, use type **CM-2040-SFG**

2) For ambient temperatures 70 degree F and above, use type **CM-2070-SFG**

f. Champion Mix Epoxy Adhesive Mixing Tip and Gun

1) Mixing Tip: **CM-MT**

2) Mixing Gun: **CM-AG**

g. A manufacturer's installer training course shall be required for electricians installing the RTRC.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Install electrical equipment and raceway system conduit in accordance with the recommendations of the manufacturer, the requirements of the National Electrical Code (NEC), local codes, and the contract drawings and these specifications.

B. Use only persons skilled and licensed in the State of Texas to perform this type of work.

3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Exposed-Outdoor and Non-Chemical Areas Above Ground Level

1. Utilize 316 stainless steel support channels to install raceways, and any other surface mounted electrical, instrumentation and control equipment. Refer to details shown on the contract drawings.

2. All mounting hardware and straps shall be 316 stainless steel.

3. Run exposed conduit parallel or at right angles to building lines.

4. Secure conduits to all cabinets and boxes with specified hubs and bonding jumpers in such a manner that each system is electrically continuous throughout.

5. Install all conduits as a complete system before wiring is pulled in. Conduits shall be reamed and swabbed clean immediately before wiring is pulled in.

6. Cap conduits during construction to prevent entrance of dirt, trash, and water.

7. Equip conduit across structural joints, where structural movement is allowed with an O.Z./Gedney, or equal, 99 % aluminum expansion fittings of that conduit size.

8. Conduit nipples shall have two independent sets of threads. Running threads shall not be used. Where conditions require joining two fixed conduits into a continuous run, a conduit union shall be used.

9. Coat all conduit threads with **LOCTITE LB 8014 Food Grade Anti-Seize or approved equal.**

10. Maintain 6-inch clearance between conduit and piping and 12-inch clearance between conduit and heat sources such as flues, steam pipes and heating appliances.

11. Arrange conduits to maintain headroom and present a neat appearance.

12. Conduits run above ground shall be supported at least every 10-feet and once in every change in direction and at the end of each straight run terminating in an enclosure and within three feet of every junction box.

13. Secure conduit runs firmly to specified support channels by stainless steel conduit straps or by hangers, as required.

14. Rigid conduit joints to be cut square, threaded, reamed smooth and drawn up tight. Bends or offsets to be made with standard conduit

ells. Make field bends with an approved bender or hickey or hub type conduit fittings. Conduit shall contain no more than the equivalent or three (3) 90-degree bends between outlets or fittings.

B. Exposed Chemical Areas

1. Run exposed conduit parallel or at right angles to building lines.

2. Secure conduits to all cabinets and boxes with specified hubs and bonding jumpers in such a manner that each system is electrically continuous throughout.

3. Install all conduits as a complete system before wiring is pulled in. Conduits shall be reamed and swabbed clean immediately before wiring is pulled in.

4. Cap conduits during construction to prevent entrance of dirt, trash, and water.

5. Equip conduit across structural joints, where structural movement is allowed with PVC expansion fittings of that conduit size.

6. Maintain 6-inch clearance between conduit and piping and 12-inch clearance between conduit and heat sources such as flues, steam pipes and heating appliances.

7. Arrange conduits to maintain headroom and present a neat appearance.

8. Conduits run above ground shall be supported per NEC requirements based on conduit size, at every change in direction and at the end of each straight run terminating in an enclosure and within 12-inches of every junction box.

9. Secure conduit runs firmly to specified support channels by fiberglass conduit straps or by hangers, as required.

10. Conduit shall contain no more than the equivalent or three (3) 90-degree bends between outlets or fittings.

11. NEC approved bender is required for bending PVC conduit. Open flame is not allowed.

C. Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete

1. Install Schedule 40 PVC conduit underground in steel reinforced duct banks changing to PVC coated rigid galvanized steel conduit at the final factory 90-degree bend, transitioning from underground to the above ground conduit system.

2. The transition from PVC coated RGS to aluminum rigid shall be made at a minimum of six (6) inches above finished slab and/or

housekeeping pad. Duct bank concrete shall extend six (6) inches above finished grade at all outdoor locations.

3. Duct banks and/or conduit banks shall be continuously reinforced along the entire length utilizing No. 4 stirrups at 1'-6" spacing and No. 5 longitudinal bars at all four corners, at a minimum. Provide 1'-6" overlap splices on all longitudinal bars.

4. Conduit support chairs shall be spaced at 5'-0" minimum spacing.

5. Duct banks shall be encased in red concrete to its final destination even when routed under building/structure, concrete floor slab, and/or equipment concrete/housekeeping concrete pad. Rebar shall be kept a minimum of two (2) inches off of the ground to allow complete concrete coverage. Concrete shall be 3000 psi. A red add mixture, HBS #120 Conduit Red as manufactured by ChemSystems, Inc., or equal, shall be added to the concrete at a minimum of 12 pounds per cubic yard of concrete. Forms shall be used unless the trench wall is stable enough to support the concrete.

    a. All form boards shall be removed after concrete has been poured and set.

    b. Stay-form may be used in lieu of form boards. Minimum clearance between form and reinforcing steel is maintained and the Stay-form does not tie to the duct bank rebar.

6. Cap conduits during construction to prevent entrance of dirt, trash, and water.

7. Provide a minimum of 2-inches separation utilizing Plastic conduit chairs between conduits installed in concrete duct bank. Spacing may be less at panel boards, pull or junction boxes or other locations where the conduits have to be grouped.

8. The minimum depth of a duct bank is twenty-four (24) inches to the top of the Concrete.

9. Duct bank conduits shall have a minimum of three (3) inches per 100-feet slope from the high point toward the manholes.

10. All underground conduit joints shall be waterproofed in accordance with the manufacturer's recommendations

11. Backfilling shall be done in such a manner that voids will be minimized. Compact backfill so that it is the same density as the surrounding soil. Excess soil shall be piled on top and shall be well tamped. All rock and debris greater than one (1) inch in size shall be removed from the site.

12. Conduits joints to be staggered a minimum of six (6) inches.

13. Where a duct bank penetrates or turns up next to a structure, dowel rebar a minimum of four (4) inches into the structure at the point of

connection/intersection tying the steel reinforcing of the duct bank to the structure at a minimum of four locations.

14. All duct banks shall be placed under building slab (not in building slab) with longitudinal duct bank steel reinforcement tied to building slab steel reinforcement with an 18-inch overlap.

15. Conduits shall penetrate building slab at 90-degrees and shall run in duct banks under building slab and not run parallel though building slabs.

16. NEC approved bender is required for bending PVC conduit. Open flame is not allowed.

17. Polyethylene Warning Tape

    a. Warning tape shall be red metal detectable polyester, 6-in minimum width.

    b. Warning tape legend shall read: "CAUTION: BURIED ELECTRIC LINE BELOW".

    c. Contractor shall place tape 6" below grade on all buried electrical duct banks or as shown on the PLANS.

D. Conduit Penetrations:

1. Use 3M 20mil corrosion tape to protect raceways for penetrations through walls, floors, and block outs and grout once work is complete. The tape should extend six (6) inches beyond the walls or floors.

2. Link-Seal modular seals shall be used for all subgrade conduit penetrations.

3. PVC pipe shall be used for all pour-in-place concrete conduit penetrations.

4. Penetrations made through fire-rated walls or floors of buildings shall be sealed with appropriate fire-stop material/product.

3.04 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Furnish and install all miscellaneous equipment as shown on the PLANS and as specified herein.

1.02 RELATED REQUIREMENTS

A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed or as indicated on the PLANS.

1.03 REFERENCES

A. DIVISION 16

B. Section 16700

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Section 01300, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

1.07 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. Factory Assembled Control Stations

1. Control stations shall be heavy-duty type, with full-size operators. Momentary contact stop buttons shall have a lockout latch that can be padlocked in the open position. Provide an extra contact to monitor the auto position of the switch as shown on the PLANS.

2. Front cover shall be bolted directly to the box without the use of latches.

3. NEMA 4X enclosures shall be 316 stainless steel.

4. NEMA 7 enclosures shall be copper free sand cast aluminum.

5. Control stations shall be Allen-Bradley or approved equal.

B. Wireway

1. Outdoors

a. NEMA 4X wire way shall be 316 stainless steel with gasketed, piano hinged covers and stainless steel type 316 screws.

b. NEMA 4X shall be Bulletin F-22 as manufactured by Hoffman or approved equal.

c. U.L. listed enclosures

2. Indoors

a. NEMA 12 wire way shall be painted carbon steel, ANSI #61 Gray, piano hinged covers and gasketed.

b. NEMA 12 shall be Bulletin F-20 as manufactured by Hoffman or approved equal.

c. U.L. listed enclosures

C. 12 VDC and 120 VAC Control Relays

1. Control relays shall have 11 pin octal base with indicating LED and contacts rated for 10 amps. Furnish 1 Normally Open (N.O.) and 1 Normally Closed (N.C.) spare contacts in addition to those required by the control scheme.

D. Timing Relays

1. Timing relays shall have 120-volt coils shall have 11 pin octal base, selectable for on-delay or off-delay functions, and settable for time delays of 0.05 seconds to 999 minutes with 10 amp contact rating. Relays shall be Square D class 9050 type JCK70 or equal.

E. Terminal Blocks

1. Terminal blocks shall be 600 Volt, channel mounted, with tubular screw and pressure plate.

2. Terminal blocks shall be Bulletin 1492 as manufactured by the Allen-Bradley Co. or approved equal.

F. Corrosion Inhibitors

1. All equipment enclosures, terminal boxes, etc, located in a NEMA 4X rated area where shown on the PLANS that contains electrical or electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.

2. The corrosion inhibitor pads shall be as manufactured by Hoffman, 3M or approved equal.

G. Fuses (0 to 600 Volts)

1. Provide a complete set of current-limiting fuses wherever fuses are indicated. Supply a set of six (6) spare fuses of each type and each current rating installed. Utilize fuses that fit mounting specified:

   a. For 0 to 600 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1 with time delay,

      1) Bussmann Type LPS-RK,

      2) Shawmut Type A6D-R, or equal.

   b. For 0 to 250 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1,

      1) Bussmann Type LPN-RK,

      2) Shawmut type A2D-R, or equal.

   c. For 0 to 600 volt feeder and service circuits, 0 to 600 amps, UL Class RK-1,

      1) Bussmann Type KTS-R,

      2) Shawmut Type A6K-R, or equal.

   d. For 0 to 250 volt feeder and service circuits, 0 to 600 amps, UL Class Rd-1,

      1) Bussmann Type KTN-R,

      2) Shawmut Type A2K-R, or equal.

   e. For 0 to 600 volt feeder and service circuits, 601 to 6,000 amps, UL Class L,

      1) Bussmann type KRP-C,

      2) Shawmut Type A4BY, or equal.

H. Indicating Lights

1. Indicator lamps shall be heavy duty 30mm, industrial type oil tight, high-visibility LED, full-voltage type. Units shall have colored screw on plastic lenses and shall have factory engraved legend plates as required. Unless otherwise specified in each equipment specification, lens color shall be green for equipment OFF, red for equipment operating, amber for FAIL and white for power ON/Equipment Stand-

by. For all control applications, indicator lamps shall incorporate a push-to-test feature.

I. Selector Switches:

1. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, MOTOR SELECTOR, LEAD-LAG, etc) shall be heavy-duty 30mm, oil tight, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Legend plates shall be black field with white markings, as indicated on the PLANS. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required by the PLANS.

J. Push Buttons:

1. Push-button shall be heavy-duty industrial type with momentary or maintained contacts as required by the PLANS, rated for 120 VAC at 10 Amps continuous. Legend plates shall be black field with white markings, as indicated on the PLANS. Button color shall be red for START and green for STOP. Contact arrangement shall be as required by the PLANS.

2. E-stop push button: Emergency stop push-button shall be red, non-illuminated, mushroom type, heavy duty, industrial type with maintained contact, rated for 120 VAC at 10 Amps continuous. Button shall be Eaton HT800 or approved equal. Where indicated on the PLANS, shroud part number Eaton E34TA6 or approved equal shall be used.

K. Combination starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Combination Starter is applicable for single motor starter only. Refer to section 16700 for further details.

L. Enclosures shall be NEMA 4X 316 stainless steel for outdoor applications and NEMA 12 for indoor applications.

M. Lighting Contactor

1. Lighting contactor shall be of the electrically operated, mechanically held type mounted in NEMA 12 enclosures (except where noted otherwise on the PLANS) with number of poles as noted on the PLANS. Operating coils shall be rated for 120 Volts unless otherwise indicated on the PLANS and shall be for momentary operation. Provide with "Hand-Off-Auto" switch on cover where shown on the PLANS.

2. Contactors shall be rated for 20 Amps, 600 VAC and shall be ASCO 918 or approved equal.

N. Photocells

1. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the PLANS.

2. 120V Photocell shall be Precision P2275 or approved equal.

3. Locking type receptacle shall be Precision M2A or approved equal.

O. Intrusion Switch: Surface mount aluminum housing contract with armored cable Interlogix Model 2507 ADL or approved equal.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 – 3.03 (NOT USED)

3.04 REPAIR/RESTORATION

A. As described in Section 16010.

3.05 – 3.06 (NOT USED)

3.07 CLEANING

A. As described in Section 16010.

3.08 (NOT USED)

3.09 STORAGE, HANDLING AND PROTECTION

A. As described in Section 16010.

3.10 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

A. Provide, furnish and install all electrical wire/s, conductor/s and cable/s (WCC) for all electrical, instrumentation and controls (EIC) work , as applicable and required, to make all electrical system/s complete and satisfactorily operable as specified here-in and designated per the Contract PLANS. Coordinate WCC accordingly for instrumentation and controls (I&C) requirements and applications.

B. All WCC work shall comply per the National Electrical Code (NEC), all applicable federal, state, and local codes, regulations and ordinances.

1.02 RELATED REQUIREMENTS

A. DIVISION 16 – Electrical

B. DIVISION 17 – Process Instrumentation and Controls System, PICS

C. ALL PROCESS AND/OR MECHANICAL PACKAGED SYSTEM/s --having electrical, instrumentation and control system/s, WCC, components, devices, etc. Reference all applicable and respective, related packaged system/s specification section/s, accordingly.

D. Other related work as may be designated, required, and/or called for per the CONTRACT DRAWINGS, other related TECHNICAL / EQUIPMENT SPECIFICATIONS and/ or as elsewhere defined or designated.

1.03 REFERENCES

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

1. NFPA 70: National Electric Code

2. U.L. 44: Thermoset-Insulated Wires and Cables

3. U.L. 510: Polyvinyl chloride, polyethylene, and rubber insulated tape

4. U.L. 1685: Vertical Tray Fire Propagation and Smoke-Release test for electrical and fiber optic cables

5. IECA S-95: Power Cables rated 2000V or less for distribution of electrical Energy

6. NECA WC-70: Power Cables rated 2000V or less for distribution of electrical Energy

7. ASTM B8: Standard Specification for concentric-lay, stranded copper conductors --hard, medium-hard, and soft

8. OWNER's Conductor Color Code standard –as designated here-in: Section 16200, 1.05D.

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittal/s per product information –catalog data sheets, product ratings, etc. per requirements and compliance per Division 1 – General Provisions, Section 01300, "Submittals".

1.07 – 1.10 (NOT USED)

1.11 OPERATION AND MAINTENANCE MANUALS

A. Operations and Maintenance (O&M) Manuals –include all approved WCC submittals in the CONTRACT O&M per Section 01730.

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. Multi-conductor I&C cable/s: Color coding is specified in the multi-conductor cable type specification--as designated per the multi-conductor cable manufacturer.

B. Power and control WCC: provide single conductor/s with integral insulation pigmentation of the designated and/or required color. Phase colors as listed below shall be provided in all instances.

C. Phase A, B, and C implies the direction of positive phase rotation for AC power voltage.

D. Implement OWNER's authorized conductor color code as designated below:

1. Electric Power WCC compliance per COA, Austin Energy Utility

System voltage/s	Conductor	Conductor Color
a. All systems	Ground	Green
b. 120/240 volts, 1-phase, 3-wire	Hot Leg, L1 Other Hot Leg, L2 Neutral, grounded	Red Black White
c. 120/208 volts,	Phase A Phase B	Red Black

3-phase, 4-wire	Phase C Neutral, grounded	Blue White
d. 277/480 volts 3-phase, 3-wire *	Phase A Phase B Phase C Neutral, grounded *	Brown Yellow Purple Gray *
***** 3-phase, 4-wire service drop from the power company; neutral is pulled and grounded at first main disconnect only; neutral conductor shall not be installed in electrical power distribution system **-- thereby standard practice does not utilize 277V, 1-phase power (line to neutral)**		
e. Motor space heater/s @ 120 volts, 1-phase wrapped	Hot Leg Neutral	Black Black w/white color vinyl tape
f. DC circuit installed in raceway	Positive (+) Negative (-)	Blue Brown

2. Control Panel WCC shall be rated 41 strand, tinned copper, 600V insulation --rated Type SIS --- WCC color code as follows:
   a. AC controls wire — Red
   b. Annunciator contacts — Yellow
   c. DC controls — Blue
   d. DC (+) power — Red
   e. DC (-) power — Black
   f. AC Hot — Black
   g. AC Neutral — White
   h. PLC/RTU discrete Input — Purple
   i. PLC/RTU discrete Output — Purple

E. All WCC shall be color coded and tagged per COA, FE AW standard per section 16205 "Wire and Cable Tagging".

F. Use the manufacturer's name, model or catalog number, if for purpose of establishing standard quality.

G. Splices are not approved –exception at lighting fixture/s and convenience receptacles.

H. Samples of all WCC shall be submitted when so requested by the ENGINEER/OWNER for the purpose of determining acceptability of the wire. WCC which have been rejected shall not be used at all. Such rejected WCC shall be removed from OWNER's premises.

I. Multi-conductor cable is NOT APPROVED.

2.03 FUNCTIONAL REQUIREMENTS

A. Single Conductors at 600V insulation rating:

1. Unless noted elsewhere or otherwise designated, all power and control WCC shall be 98% conductivity, soft annealed, stranded copper with 600V insulation -- rated Type XHHW-2. Grounding WCC shall be bare, hard annealed, stranded copper.

2. Use only WCC meeting applicable requirement per UL 44, UL 1685 and IECA S-95-658 (NEMA WC70).

3. Power WCC shall not be smaller than #12 AWG, unless otherwise noted on the Contract PLANS.

4. Control WCC shall not be smaller than #14 AWG.

5. WCC shall be marked every two feet (2'-0") with the size, type and voltage rating as well as the Manufacturer's name and measurement markers.

6. Unless otherwise noted, conductor size/ampacity rating indicated are based on copper conductor. Do not provide conductor smaller than that designated -- comply per N.E.C.

7. Approved WCC manufacturers: Anaconda, Cyprus (Rome), Southwire, Okonite, Triangle, or approved equal.

8. Where flexible power/power and controls cords and cables are supplied, provide same per Type SEOOW rated -- flexible stranded copper conductor/s, 600V insulation rating –with quantity and size conductors as required and/or where designated per the CONTRACT PLANS.

B. Single Pair Instrumentation Cable – #16 AWG, stranded, twisted, shielded pair (2), 98% conductivity copper conductors, 600V insulation and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% pair conductors coverage -- rated Type TC Cable

   1. Single pair instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Shall be rated for cable tray, conduit and/or other approved raceway. Minimum temperature rating shall be 90-degree C dry locations, 75-degree C wet locations.

C. Single Triad Instrumentation Cable – #16 AWG, stranded, twisted, shielded triad (3) copper conductors, 600V insulation, and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% triad conductors coverage -- rated Type TC Cable

   1. Single triad instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Suitable for installation in cable tray/s, conduit and/or other approved raceway/s. Minimum

temperature rating shall be 90-degree C dry locations, 75-degree C wet locations.

D. Equipment Grounding Wire/Conductor:

1. Provide stranded, copper conductor/s as designated, shown and required per N.E.C. for electrical system grounding and equipment grounding.

2. Provide conductor/s with green color, 600V insulation, minimum thickness of 1/32 inch -- rated Type XHHW-2.

E. All control panel wiring shall be flexible, 41 strand, tinned copper, 600V insulation, Type SIS -- not smaller than #14 AWG (unless approved by Austin Water), color coded as outlined here-in per section 16200 2.02 D.2.

F. All WCC shall be new, unused, in good condition and shall be delivered in standard coils, packages or reels. If wire used is different than what is specified, samples of wire shall be submitted for the purpose of determining acceptability of the wire. Wire which has been rejected shall not be used again. Such rejected wire shall be removed from the Owner's premises. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner or his representative.

G. Power conductors shall not be smaller than No. 12 AWG, except for control and alarm wiring where No. 14 AWG shall be used as minimum size wire when protected by a 15 amp fuse/circuit breaker.

H. The contractor may, if he deems it necessary or advisable, use larger sized conductors than those required. In no case shall there be a voltage drop greater than that allowed by the N.E.C.

2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Do not exceed WCC manufacturer's recommendations for maximum pulling tension and minimum bending radii. Pulling compound shall be used. Use only UL listed compound compatible with WCC outer jacket and with the raceway utilized.

B. Contractor shall provide and install all low voltage (120V, 208V, 240V, 480V, etc.) WCC for power distribution equipment and associated hardware designated and required per the CONTRACT PLANS.

C. Tighten all screws and terminal bolts using torque type wrenches, and/or drives to tighten to the inch-pound requirements of the NEC and UL.

D. When single WCC in man-holes, hand-holes, vaults, cable trays and other designated location and/or raceway(s) are not wrapped together by some other means, such as arc and fireproofing tapes, bundle throughout their exposed length conductor(s) entering from each conduit/raceway with nylon, self-locking, releasable cable ties placed at interval not exceeding 12 inches on-centers.

3.02 PREPARATION (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Support all conductors in vertical conduits or raceways in the manner set forth in Article 300-19 of the latest revision of the National Electric Code. Do not use lighting fixtures for raceways or circuits other than parallel wiring of fixtures.

B. Do not make any splices or taps in any conductor except where absolutely required for 120 volt circuits feeding lights or receptacles. Such splicing may only take place in splice/junction boxes. Elapsed time meters are the only exception to not using a junction box.

C. Tag all power wiring in all pull boxes, wire ways, motor control center wire ways, panel board wiring gutters, light switch boxes, receptacles, disconnect switches etc. Use heat shrinkable slip-on type tags, approved for this use, as manufactured by Raychem, 3M, Panduit, or owner approved equal. See Section 16205, Wire and Cable Tagging Standard for additional requirements.

D. All interconnect wiring going from one compartment to another, or between two separate pieces of equipment must terminate at a terminal block on each end, i.e. entering and leaving a compartment or piece of equipment.

E. All wiring passing between cabinets shall be protected by a rubber grommet or approved nipple with bushings.

F. All wire terminations shall be made with a mechanical compression type lug or terminal specifically designed to accept stranded wire. Do not terminate by wrapping the wire around the screw.

G. Number 8 AWG and larger wire shall utilize a crimper with a die set to install lugs to the wire.

H. No more than two wires/ lugs per terminal will be allowed unless ring type lugs are used. A maximum of three wires will be permitted if all wires are using ring lugs.

I. All current transformer loops shall utilize ring terminals and shorting terminal boards to avoid open circuiting the secondary of a CT.

J. All wiring run to the front door panel shall have a spiral wrap and tie wrapped to protect wires from being pinched between door and panel. A loop (slack) in conductor(s) shall be provided to allow door to open freely.

K. All main panel wiring shall be run in a raceway such as Panduit. All wiring run from the Panduit to the devices shall be neatly run and tie wrapped. If Panduit is not practical, wires shall be neatly run and tie wrapped.

L. Equipment grounding wire run in conduit shall have an identifying green covering or green color coding at each end terminations and at junction box or pull box locations along its run length.

M. Where the capacity of a single feeder is great enough to require parallel conductors in more than one (1) conduit, each conduit must contain the same number and length of conductors in all phases (legs) of the feeder, including any neutral conductors per the N.E.C.

N. Under no circumstance shall circuits above 600 volts and those below 600 volts be pulled in the same conduit.

O. Separate low level circuits (such as phone line) from noisy and power circuits by a minimum distance of 1 foot.

P. Bolted and compression connections/terminations for electrical conductors shall be thoroughly cleaned, covered, and sealed with a light, pliable, waterproof film of commercial paste or sealant to prevent oxidation and/or corrosion. Apply sealant to cover complete conductor termination and cover/extend past end of conductor insulation. This is typically required for Wastewater Facilities and hazardous, damp and/or corrosive areas. Acceptable conductor/termination sealant manufacturers are Noalox or approved equal. Include sealant submittal data with WCC submittals.

Q. Where mechanical assistance is used for pulling conductors, a wire pulling compound shall be used (Polywater, or approved equal, as indicated by conductor manufacturer) having inert qualities that do not harm the wire insulation or covering and shall be free from grease, filings or foreign matter before conductors are pulled. Do not exceed cable Manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

R. Wiring shall be tagged with Raychem Wire Markers, or approved equal, at panel boards, and all termination points with numbers conforming to Section 16205. Power wiring labels shall be white with black letters.

S. Lighting and receptacle wiring may use silicone filled spring type wire connectors in approved locations. This applies to lighting and receptacle circuits only.

T. In no case shall DC voltage circuits and AC circuits be pulled in the same conduit or raceway.

3.04 – 3.07 (NOT USED)

3.08 TESTING AND INSPECTION

A. Field test, check and inspect all installed WCC --- comply per requirements per Section 16951 "Calibration and Testing".

3.09 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This specification section establishes the wire, conductor and cable tagging method to use for all electrical, control and instrumentation systems for the Austin Water.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. WIRE, CONDUCTOR AND CABLE TAGGING

1. In general, all wiring shall be tagged at all termination points and at all major access points in the electrical raceways. A termination point is defined as any point or junction where a wire or cable is physically connected. This includes terminal blocks and device terminals. A major access point to a raceway is defined as any enclosure, box or space designed for wire pulling or inspection and includes pull boxes, manholes, and junction boxes.

2. Wire tags shall show both origination and destination information to allow for a wire to be traced from point-to-point in the field. Information regarding its destination shall be shown in parenthesis.

B. Single Conductor, Wire and Cable Tagging

1. The following is the format to use for single conductor, wire and/or cable tags. Tag information to the left refers to the origination point. Tag information in parenthesis refers to point of destination.

   XXXX XX (XXXX-XXXX-XXXXX / XXXX XX)

   Device Terminal Identifier No. (Equipment Tag No.*/Device Terminal Identifier No.)

   *For wiring within a piece of equipment, control panel, junction box, etc., the Equipment Tag No. is not required, only the Device Identifier and Terminal Number from the point of origination.

Example: For a wire connected from Terminal block 1 terminal 23 to relay CR1 terminal 9, the correct tag would be TB1-23(CR1-9) at the terminal block and CR1-9(TB1-23) at the relay.

C. Device Identifier

1. The Device Identifier uniquely identifies a device within a piece of equipment. Examples are: TB1, for terminal block number 1 and CR02, for control relay # 02. For existing equipment, refer to existing device tags or labels and/or equipment documentation. For missing tags or new equipment, consult with OWNER.

D. Terminal Number

1. The Terminal Number along with the Device Identifier, identify which specific point in the equipment the wire must be terminated to. Refer to manufacturer's labeling or record drawings for device terminal numbers.

E. Equipment Tag No.

1. The Equipment Tag Number is the physical tag attached to the equipment. For existing equipment, please refer to the Facility in question. For new or missing equipment tags please refer to the Contract PLANS Mechanical Systems for equipment tag identification and/or designation.

F. TAG SPECIFICATIONS

1. Wire tags shall be yellow for control wiring and white for all AC/DC power wiring. Tags shall be heat shrink type as manufactured by Raychem, 3M, Panduit, or OWNER approved equal with the tag numbers typed with an indelible marking process. Character size shall be a minimum of 1/8" in height. Hand written tags are not allowed. Tags shall be heat shrunk once proper installation and operation is completed and verified.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. PULL BOXES, MANHOLES, AND JUNCTION BOXES

1. For all groups of conductors, tags shall be yellow Phenolic with black lettering, attached with black tie wraps. Submit tag sizing and nomenclature to OWNER for approval.

B. DEVIATIONS

1. For deviations from this wire tagging specification, or for cases not covered by these specifications, submit the proposed tagging system to Austin Water for approval prior to use.

C. GRAPHIC DISPLAY

1. Comply per the following graphic display/outline for the specified conductor/wire/cable tagging method.

2. Single conductor wire tagging within same enclosure and/or equipment.

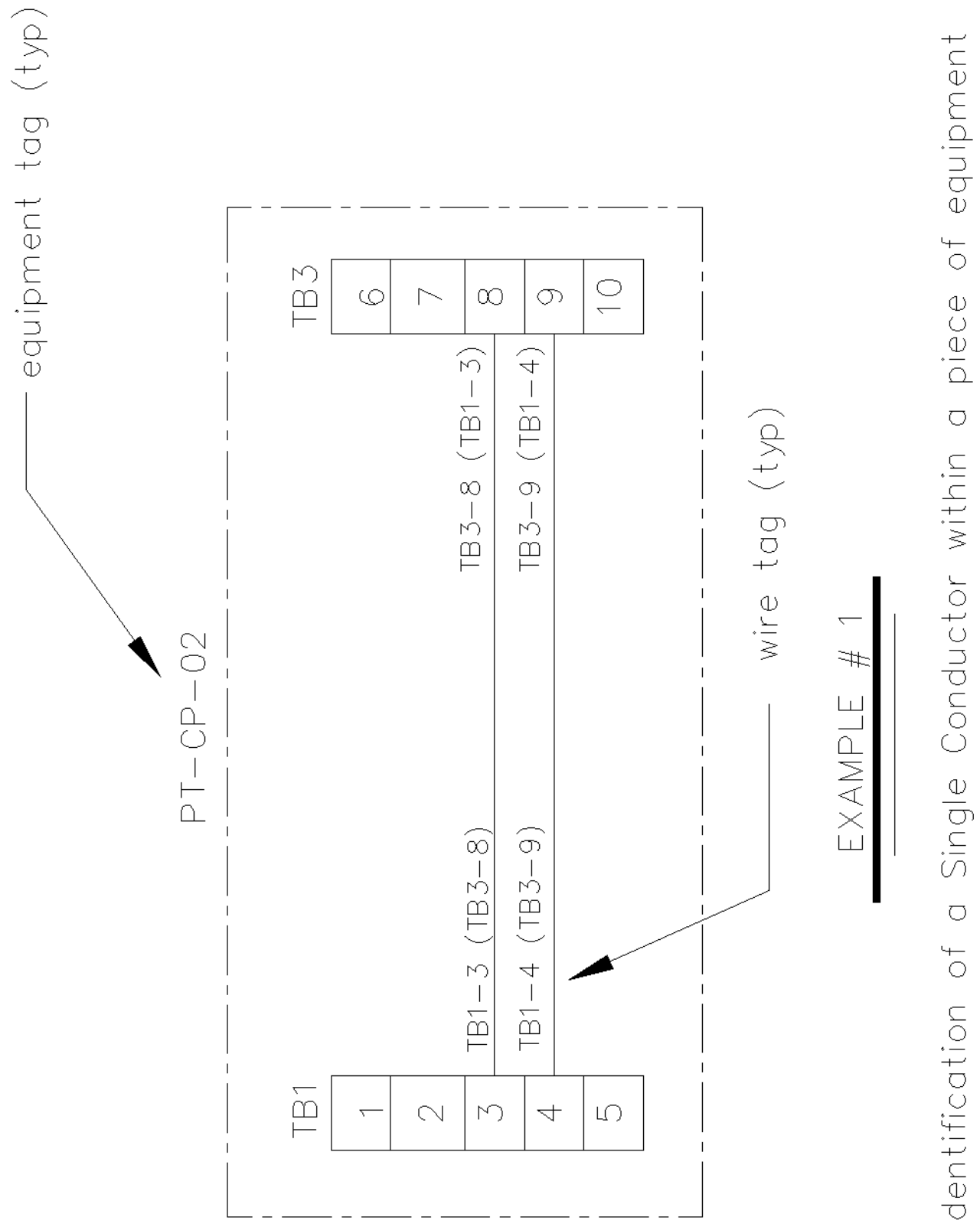
3. Single conductor wire tagging between two separate enclosures and/or equipment.

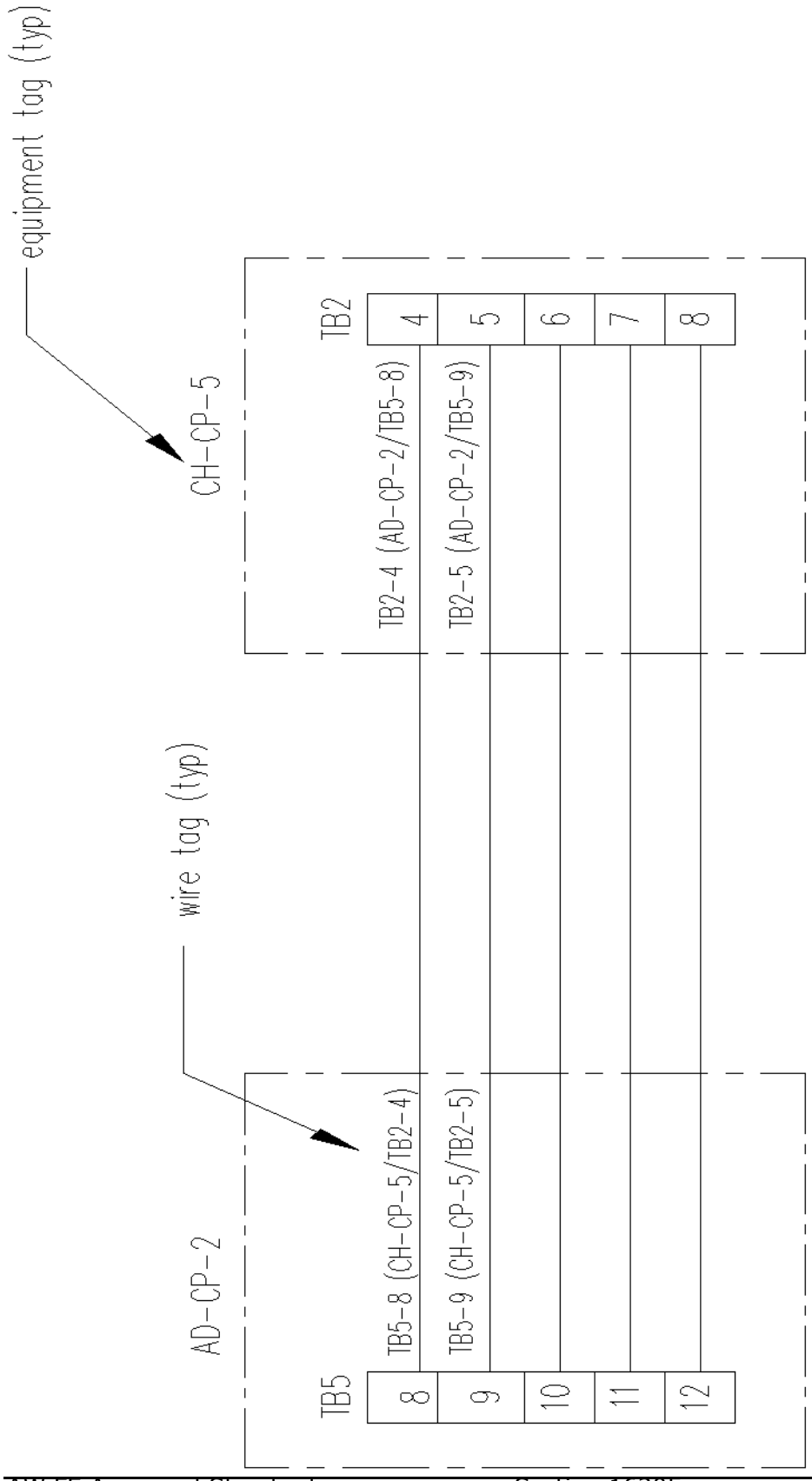
3.02 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION


equipment tag (typ)
PT-CP-02
TB3
6
7
8
9
10
TB3-8 (TB1-3)
TB3-9 (TB1-4)
TB1-3 (TB3-8)
TB1-4 (TB3-9)
TB1
1
2
3
4
5
wire tag (typ)
EXAMPLE # 1
Identification of a Single Conductor within a piece of equipment



EXAMPLE # 2

Identification of a Single Conductor that interconnects two pieces of equipment

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PART I - GENERAL

1.01 SCOPE

A. This specification covers squirrel-cage, three-phase 60 Hertz, induction motors in ratings up to 200 horsepower. Each motor shall be electrically and mechanically suited for the drive to which it shall be applied. Motors for vertical applications shall be designed specifically for vertical operation and shall be mounted on NEMA "P" bases.

B. Motors designed for use with variable frequency drives shall be inverter duty rated

1.02 QUALITY ASSURANCE

A. The drive manufacturer who supplies the motor shall coordinate with the motor supplier on dimensions and frame size. The specification calls for a premium design, and usual dimensions may not apply.

B. The manufacturer of the motor shall coordinate closely with the manufacturer of the drive, so that all physical and operational characteristics of the motor are compatible with the requirements of the drive.

C. Applicable Manufacturers. The motor shall be as specified herein as manufactured by General Electric, Gould, Reliance, Baldor, or approved equal.

D. Motors shall be designed, built and tested in accordance with the latest revisions of the following standard documents:

1. NEMA MG1 – Motors and Generators

2. ANSI/IEEE 112 – Test Procedures for Motors/Generators

3. UL 1004 – Motors, Electric

4. UL 674 – Motors, Generators, Electric, for use in Hazardous Locations: Class I, Groups C and D; Class II, Groups E, F, and G.

5. Provide minimum nominal motor efficiency per ASHRAE 90.1 2010.

1.03 RELATED SECTIONS

A. 01730 O&M Manuals

B. 16130 Boxes and Cabinets

C. 16200 Wires, Conductors, and Cables- 600V and Below

D. 16480 Variable Frequency Drives

E. 16487 Solid State Voltage Motor Starters

F. 16950 Calibration and Testing

1.04 SUBMITTALS

A. Identifications. Identification of the unique motor design, e.g. style number or shop order number and the remaining motor information listed below shall be submitted for each drive application and shall be based on actual motor test data of an existing design. If this information cannot be based on actual motor testing, it shall be identified and shall be offered as a guarantee of the proposed design, and certified test results shall be submitted after the motor has been built.

B. Motor Information to be submitted.

1. Motor Manufacturer and Style No.
2. Horsepower
3. Efficiency at 4/4, 3/4, 1/2, 1/4 load, and at design conditions.
4. Power factor at 4/4, 3/4, 1/2, 1/4 load, and at design conditions.
5. Insulation application procedures
6. Insulation class
7. Dimensioned outline drawings.
8. Locked rotor amps.
9. Full load amps, and amperes at design load.
10. Motor weight.
11. Type paint used.
12. Full load rpm.
13. Frame size.
14. Maximum temperature rise at unity service factor for insulation proposed, and at 1.15 service factor.
15. Starting and breakdown torque in percent of full load torque.
16. Thrust capabilities (vertical).

17. Noise level, "A" scale.

18. Resonant Frequency.

19. Winding resistance at 40 deg. C and 80 deg. C or 105 deg. C.

20. Bearing life, number of years minimum, as defined by, AFBMA.

21. Space heater wattage and voltage

C. It shall be noted that the submittals will not be acceptable unless all of the above information is submitted at one time, along with respective pump or equipment.

PART II - PRODUCTS

2.01 GENERAL

A. The motor shall operate efficiently, without overloading, overheating, or abnormal vibration, throughout the entire range of speed and load. There shall be no point on the drive range or pump curves at which the motor exceeds its horsepower rating (at unity service factor), even momentarily. The motor shall have, in addition, a service factor rating of 1.15. Minimum starting torque shall be in accordance with NEMA Design Letter "B", unless the application indicates a more severe requirement. Minimum accelerating torque shall not be less than 100 percent of full-load torque at rated voltage.

B. Single phase motors shall be rated 120/240 VAC. Three phase motors shall be rated 230/460 VAC.

C. Motors less than ½ HP shall be squirrel cage induction type, capacitor start with copper stator windings. Motors shall be continuously rated with 1.15 service factor.

D. Motors ½ HP and larger shall be 3 phase, continuously rated, squirrel-cage, random-wound copper, induction motors rated for continuous operation with 1.15 service factor.

2.02 ENCLOSURES

A. Unless otherwise indicated, the motor shall be high efficiency and high power factor type, TEFC enclosures with a 1.15 service factor. The motor shall have moisture-proof premium insulation, drain breathers, grease plugs, oversize conduit box containing a ground lug, space heater wiring, stainless steel nameplate, epoxy paint, and corrosion-resistant treatment on rotor, stator, and end shields. Motors 40 HP and above shall have an extra factory installed and wired, control cable conduit box with terminal blocks.

B. Provide TEFC motors with anti-friction grease lubricated ball bearings with a bearing AFBMA B-10 life of 100,000 hours when the motor is operated

continuously at rated speed, considering weight of rotor plus combined dead weight and drive load thrust. Provide factory lubrication of all motors before shipment. Provide all grease-lubricated bearings with relief fittings.

C. Provide all ODP motors with sealed anti-friction grease-lubricated ball bearings with a bearing AFBMA B-10 life of 100,000 hours when the motor is operated continuously at rated speed, considering weight of rotor plus combined dead weight and drive load thrust. Provide factory lubrication of all motors before shipment. Provide all grease-lubricated bearings with relief fittings.

D. Motors larger than Nema Frame sized, may have Weather Protected Type II enclosures with encapsulated (sealed) insulation, but shall however; comply with all other aspects of the specifications. Provide screens over all air openings.

E. Motors for use with variable frequency drives shall be inverter duty rated meeting NEMA MG-1, Part 3.1 with 1600 Volt rated magnet wire.

F. Insulated or isolated bearings shall be furnished for inverter duty rated motors.

G. The inverter duty rated motor shall be constructed with triple film wire, increased winding slot insulation, increased insulation between phases, and increased first turn insulation. Slot fillers shall be used to avoid loose windings.

H. Motor enclosure winding and insulation application:

1. The following shall apply unless modified by specific specification sections:

MOTOR LOCATION	MOTOR ENCLOSURE/WINDING INSULATION
Unclassified Indoor Areas	DFPG (for horizontal motors
Wet Indoor Areas	TEFC, Standard Insulation
Corrosive Areas	TEFC, Extra Dip and Brake for Moisture
Class I, Division I Areas	Explosion Proof, Approved for Class I, Division I Areas
Class II, Division I Areas	Explosion Proof, Approved for Class II, Division I Areas
Class I or Class II, Division II Areas	Explosion Proof, Approved for Division I locations or TEFC

2.03 INSULATION

A. The insulation shall be NEMA Class "F" designed for Class "B" temperature rise based on 40 deg. C ambient. Insulation for Inverter Duty motors shall be Class "H" with Class "B" temperature rise.

B. Insulation for motors located in Class I Division I areas shall be determined by the maximum allowable temperature rise, as dictated by the autoignition temperature rating of the hazardous gas or vapor.

2.04 WINDING

A. All windings shall be copper.

B. Winding space heaters shall be furnished on all motors installed outdoors and elsewhere as indicated on the drawings.

   A. Space heaters installed in motors located in Class I, Division II areas shall be identified for Class I, Division II locations. The exposed surface of space heaters shall not exceed 80 percent of the autoignition temperature of gas or when operated at rated voltage. The maximum space heater surface temperature shall be permanently marked on a visible nameplate mounted on the motor.

2.05 TEMPERATURE RISE

A. The maximum temperature rise above 40 deg. C ambient, at a service factor of 1.15, shall be 80 deg. C.

B. The maximum temperature rise for motors located in hazardous area shall be determined by the T-code rating determined by the autoignition temperature of the gas or vapor present in the hazardous (Class I/ Division I or Class I, Division II area.

2.06 RESONANT FREQUENCY

A. The critical speed of the shaft and rotor assembly shall exceed the operating speed by a minimum of 25 percent.

2.07 NOISE LEVEL

A. The motor shall conform in sound level to the Walsh-Healy Public Contracts Act minimum listing for continuous operation.

2.08 DIRECTION

A. In general, the motors are to be bi-directional. If the fan must be uni-directional, it will be the electrical manufacturer's responsibility to obtain the direction required from the manufacturer.

2.09 NAMEPLATE

A. The stainless steel nameplate shall indicate the number of starts allowable per hour, and per 24 hours, without significantly reducing the motor life. The nameplate shall also specify the minimum B10 life as defined by Anti Friction Bearing Manufacturers Association (AFBMA), NEMA design torque rating, phase, hertz, KVA code letter, horsepower, full load rpm, Frame No., max ambient temperature, voltage, serial number, full load amps, style number or shop number that uniquely fits the motor description as submitted in paragraph 1.03, Items 1 through 21, all bearing style numbers, sound levels in dBA, i.e. pressure at 3 feet and power measured per IEEE 85.

B. Inverter duty rated motor nameplates shall indicate that the motor is an inverter duty motor.

2.10 LOCAL CONTROL STATION

A. A control station shall be installed at each motor for local control of that motor.

B. Control station shall be installed on an approved support adjacent to the motor in a location which will not interfere with operation or maintenance of the motor.

C. Control stations located outdoors and in wet locations indoors shall be installed in Nema 4X 316 stainless steel enclosures. Those located indoors shall be installed in Nema 12 enclosures.

D. Control stations located adjacent to motors located in hazardous areas shall be mounted and installed outside of the hazardous area boundary.

E. Refer to Electrical and Instrumentation plans for specific controls required at individual control stations.

PART III - EXECUTION

3.01 FACTORY TESTING

A. Production Tests - AC Motors: Each motor shall receive a routine commercial test per NEMA MG-1-12 and IEEE Std. 112. Prototype test reports shall be supplied for each rating.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment for a period of three (3) working days. The manufacturer's representative shall provide technical direction and assistance to the Contractor in the general assembly of the motor, connections and adjustments, and testing of the motor and components contained therein.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:

1. Verification of proper mounting and alignment.

2. Final inspection of the lubricating system.

3. Final inspection of the cooling system.

4. Meggar test.

5. Final coupled test.

C. The contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.03 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.

3.04 INSTALLATION

A. The motors shall be installed by the Contractor in accordance with the manufacturer's instructions.

B. Any slushing compound on the shaft or other parts shall be removed using a petroleum-type solvent.

C. Any and all shaft shipping braces shall be removed after the motor is placed in its final location.

D. The motor shall be mounted in accordance with the manufacturer's instructions. Special care shall be taken to ensure that the motor shaft is level.

E. If a soleplate has been provided, it must be located, leveled and grouted into place following the best practices.

F. The Contractor shall install the motor coupling in accordance with the coupling manufacturer's instruction. Under no circumstances shall the motor shaft be modified to accommodate the coupling.

G. The motor shall be aligned axially with driven equipment. This alignment shall be done in accordance with the manufacturer's instruction.

H. Incoming power connections shall be made in accordance with this specification and the section dealing with wiring practices.

I. All secondary wiring connections shall be made in accordance with the Contract documents and manufacturer's wiring diagrams.

J. The motor space heaters shall be connected to a reliable 120V AC source. Space heaters shall be energized when motors are stored outside or in damp areas inside.

K. Motor bases shall be connected to the grounding system.

3.05 FIELD ADJUSTMENTS

A. The Contractor shall fill any oil reservoir with the manufacturer's specified oil.

B. If the manufacturer requires that the anti-friction bearings receive an initial change of grease, the Contractor shall perform such work.

C. The motor shaft shall be turned by hand to ensure there is free rotation.

D. For TEFC motors, the area around the external fan inlet shall be checked for loose debris that could be drawing into the fan during operation.

E. All external, factory-made, bolted joints should be checked for tightness.

3.06 FIELD TESTING

A. Furnish equipment manufacturer services and specified in the individual equipment specifications.

B. Inspect wire for physical damage and proper connection.

C. Prior to energizing the motor provide insulation resistance test as noted in the attached Motor and Feeder Testing Report.

1. Test each phase separately.

2. Testing shall comply with NEMA MG-1 safety requirements and procedures.

D. Bump the motor to check for rotation.

1. Ensure motor has been lubricated.

2. Check prior to connection to driven equipment.

E. The Contractor shall make an initial uncoupled test of the motor:
1. The motor shaft rotation shall be noted and verified that it is turning in the proper direction.

2. The motor bearing temperatures shall be monitored for excessive temperatures or excessive vibration. If any abnormal vibration or noise occurs the motor shall be immediately stopped.

3. A factory-trained manufacturer's technician shall inspect and test the motor prior to any further operation.

F. The Contractor shall make coupled start-up tests:

1. The starting time should be measured and verified that it is less than the manufacturer's rated stall time.

2. When the motor reaches full speed, the motor shall be carefully observed to verify that there is not excessive vibration or noise. The bearing temperatures shall be monitored to verify proper cooling.

3. Measure the line-to-line voltages.

4. Measure the phase currents. Current imbalance shall be within 5%.

5. In addition, the Contractor shall verify that the cooling and lubrication systems are operating properly. For motors with external systems, the temperature, pressure, flow rate, etc. shall be verified as correct.

G. The Contractor shall submit the attached testing report with the O&M manuals.

MOTOR AND FEEDER
TEST REPORT

MOTOR NO. _____ OWNER _____

LOCATION _____ CONTRACTOR _____

DATE _____ WITNESS _____

MANUFACTURER _____ SERIAL NO. _____
HP _____ SF _____

FLA _____ LRA _____ VOLTAGE _____ PHASE _____

FEEDER SIZE _____

1. Inspect for damage and missing parts. _____
2. Check nameplate for proper HP, Design, Voltage, SF, FLA and LRA. _____
3. Inspect for proper anchorage and mounting. _____
4. Inspect for proper feeder and grounding termination at motor and at starter. _____
5. Check motor space heaters for proper operation. _____
6 Test motor winding resistance, megohms(1). _____

Phase A - Phase B _____Megohms. Phase A - Ground _____Megohms.
Phase B - Phase C _____Megohms. Phase B - Ground _____Megohms.
Phase C - Phase A _____Megohms. Phase C - Ground _____Megohms.

7.Test motor feeder insulation resistance, megohms(2). _____

Phase A - Phase B _____Megohms. Phase A - Ground _____Megohms.
Phase B - Phase C _____Megohms. Phase B - Ground _____Megohms.
Phase C - Phase A _____Megohms. Phase C - Ground _____Megohms.

8. Perform continuity test on feeder and ground cables. _____
9. Perform continuity test on control wiring. _____
10. Test motor for proper rotation. _____
11. Record starter MCP, OL Heater and motor FLA. _____

(1) Insulation resistance tests per IEEE Std. 43. Test duration for motors larger than 200 HP shall be 10 minutes with resistances tabulated at 30 secs., 1 min. and 10 min. Record lowest value. Test duration for motors 200 HP and less shall be 1 minute with resistances tabulated at 30 and 60 secs. Record lowest value.

(2) Apply 1000 Volts DC for a 1 minute period. Investigate any values less than 50 megohms.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. This Section includes surge protection devices for low-voltage power, control, and communication equipment.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 (NOT USED)

1.04 DEFINITIONS

A. SVR: Suppressed Voltage Rating

B. SPD: Surge Protection Devices

C. TVSS: Transient Voltage Surge Suppression

1.05 (NOT USED)

1.06 SUBMITTALS

A. Product Data: For each type of product indicated include the following:

1. Rated capacities
2. Dimensions
3. Weights
4. Operating characteristics
5. Furnished specialties
6. Accessories

B. Product Certificates: Shall be signed by product manufacturer certifying compliance with the following standards:

1. UL 1283 - Electromagnetic
2. UL 1449 3rd Edition – UL Standard for Surge Protection Devices

C. Operation and Maintenance Data:

1. Include Operation and Maintenance Manuals

D. Warranties: Special warranties specified in Section 1.10.

1.07 QUALITY ASSURANCE

A. Source Limitations

1. Obtain all SPD and accessories from a single manufacturer.

B. Product Options

1. Drawings indicate size, dimensional requirements, and electrical performance of surge protection device and are based on the specific system indicated.

C. Electrical Components, Devices, and Accessories

1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage (1000 Volts or less) AC Power Circuits."

E. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Standard for Surge protection device/ss."

1.08 – 1.09 (NOT USED)

1.10 WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge protection devices that fail in materials or workmanship within ten years from date of Substantial Completion.

1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Electric Company

2. Innovative Technology, Inc.

3. Square D/ Schneider Electric

4. Eaton/Cutler Hammer

5. Surge Suppression Incorporated

2.02 MATERIALS/CONSTRUCTION

A. Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.

2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

3. Humidity: 0 to 85 percent, non-condensing.

4. Altitude: Less than 20,000 feet (6090 m) above sea level.

2.03 FUNCTIONAL REQUIREMENTS

A. Power Distribution Panelboard Surge Protection Device

1. Surge protection device with the following features and accessories:

a. Fuses, rated at 200-kA interrupting capacity.

b. Fabrication using bolted compression lugs for internal wiring.

c. Integral disconnect switch.

d. Redundant suppression circuits.

e. Redundant replaceable modules.

f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

g. LED indicator lights for power and protection status.

h. Audible alarm, with silencing switch, to indicate when protection has failed.

i. One set of dry contacts rated at 5A and 250Vac, for remote monitoring of protection status.

j. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 120 kA / phase

C. Connection Means: Permanently wired.

D. Protection modes and UL 1449 SVR for grounded wye circuits of 480Y/277V, 3-phase, 4-wire (w/ neutral) and ground circuits and 480V, 3-phase, 3-wire and ground circuits shall be as follows:

1. Line to Line: 3000 V
2. Line to Neutral: 1200 V
3. Line to Ground: 1000 V
4. Neutral to Ground: 1000 V

E. Protection modes and UL 1449 SVR for grounded wye circuits of 208Y/120V, 3-phase, 4-wire (w/ neutral) and ground circuits and 120/240V, 1-phase, 3-wire (w/ neutral) and ground circuits shall be as follows:

1. Line to Neutral: 700V
2. Line to Ground: 600V
3. Neutral to Ground: 600V

F. Class 1, Class 2, Class 3 circuits and remote controls & communications low voltage circuits surge protection device

1. Surge protection device with the following features and accessories:
   a. Fuses, rated for required interrupting capacity.
   b. Redundant suppression circuits.
   c. Redundant replaceable modules.
   d. Arrangement with wire connections to circuit and ground bus.
   e. LED indicator lights for power and protection status.
   f. Surge-event operations counter.
2. Peak Single-Impulse Surge Current Rating: 10 kA
3. Connection Means: Permanently wired.

G. Protection modes and UL 1449 SVR for Class1, Class 2, Class 3 circuits and remote/controls/communication low voltage rated circuits as follows:

1. Line to Neutral: 500 V
2. Positive to Negative (Ground): 500 V

2.04 (NOT USED)

PART III - EXECUTION

3.01 (NOT USED)

3.02 PREPARATION

A. PLACING SYSTEM INTO SERVICE

1. Do not energize or connect service entrance equipment, panelboards, control terminals, data terminals to their sources until surge protection devices are properly installed and connected.

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS INSTALLATION OF SURGE PROTECTION DEVICES

A. Install 480Y/277V rated surge protection device at enclosed circuit breaker/disconnect.

B. Install appropriately rated surge protection device in control equipment/panel/etc. circuits and schematics for applicable low voltage controls/communications and Class 1, Class 2, Class 3 circuits.

C. Do not interrupt utilities serving facilities occupied by OWNER or others until arranging temporary utility services according to requirements indicated:

a. Notify ENGINEER and OWNER not less than two working days in advance of proposed utility interruptions.

b. Do not proceed with utility interruptions without ENGINEER'S written permission.

D. Coordinate location of field-mounted surge protection devices to allow adequate clearances for maintenance.

3.04 (NOT USED)

3.05 FACTORY AND FIELD QUALITY CONTROL

A. Remove and replace malfunctioning units and retest.

3.06 – 3.10 (NOT USED)

3.11 TRAINING

Engage a factory-authorized service representative to train OWNER'S maintenance personnel to adjust, operate, and maintain transient voltage surge protection devices for two sessions of at least 4 hours for each session. Times shall be coordinated with the OWNER.

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install, where indicated, a free-standing, dead-front type, front access only, low voltage distribution switchboard, utilizing group mounted circuit protective devices as specified herein and as shown on the contract drawings.

B. The Switchboards shall include the following:

1. Main Service Disconnect.

2. Rating shall be as indicated in the drawings.

1.02 RELATED SPECIFICATIONS

A. Section 16010– Submittals

B. Section 16010 – Contract Closeout

C. Section 16390 – Power System Studies

D. Section 16010 – Electrical General Requirements

1.03 REFERENCE STANDARDS

A. The switchboard and all components shall be designed, manufactured, and tested in accordance with the latest applicable following standards:

1. NEMA PB-2

2. UL Standard 891

3. UL Standard 1066

4. UL Standard 489

5. UL Standard 1449 4th edition

1.04 SUBMITTALS FOR REVIEW

A. The following information shall be submitted to the Engineer:

1. Master drawing index

2. Front view elevation

3. Floor plan
4. Top view
5. Single line
6. Schematic diagram
7. Nameplate schedule
8. Component list
9. Conduit entry/exit locations

B. Assembly ratings including:

1. Short-circuit rating
2. Voltage
3. Continuous current

C. Major component ratings including:

1. Voltage
2. Continuous current
3. Interrupting ratings

D. Cable terminal sizes

E. Product data sheets

F. Comply with Sections 01330 AND 16010

G. Where applicable, the following additional information shall be submitted to the Engineer:

1. Busway connection
2. Connection details between close-coupled assemblies
3. Composite floor plan of close-coupled assemblies
4. Key interlock scheme drawing and sequence of operations

1.05 O&M MANUALS

A. All Contractors shall provide Operation and Maintenance Manuals in accordance with Sections 01730. The following information shall be included:

1. Final as-built drawings and information for items listed in Paragraph 1.0 and shall incorporate all changes made during the manufacturing process.

2. Wiring diagrams

3. Certified production test reports

4. Installation information

5. Recommended spare parts

1.06 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.07 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

B. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins, and renewal parts lists, where applicable, for the complete assembly and each major component.

PART II - EXECUTION

2.01 MANUFACTURERS

A. Eaton / Cutler-Hammer Pow-R-Line C

B. Schneider Square D

C. ABB

D. Engineer Approved Equal

E. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 RATINGS

A. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.

B. Voltage rating to be as indicated on the drawings.

C. Switchboard shall be service entrance rated.

2.03 CONSTRUCTION

A. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

B. All sections of the switchboard shall be front, and rear aligned with depth as required. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.

C. The switchboard shall be of front access arrangement.

D. The assembly shall be provided with adequate lifting means.

E. The switchboard shall be equal to Cutler-Hammer type Pow-R-Line C utilizing the components specified herein and as shown on the drawings.

F. The switchboard shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

2.04 BUS

A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

B. Provide a full capacity neutral bus.

C. A copper ground bus (minimum 1/4 x 2 inch) shall be furnished firmly secured to each vertical section structure at the bottom and shall extend the entire

length of the switchboard.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

2.05 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

B. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.

C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

D. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.06 CIRCUIT BREAKERS

A. Where indicated circuit breakers shall be UL listed for series application.

B. Where indicated circuit breakers shall be current limiting.

C. Circuit breakers shall be UL listed for applications at 100% of their continuous ampere rating.

D. Breakers shall be as follows:

1. 225 Amp – Eaton HFDE with Digitrip 310 trip unit.

2. 400 Amp – Eaton HKD with Digitrip 310 trip unit.

3. 800 Amp – Eaton NGH with Digitrip 310 trip unit.

4. 1600 Amp – Eaton Magnum SB with RMS 520 LSIG trip unit.

5. 3000 Amp – Eaton Magnum SB with RMS 520 LSIG trip.
6. 4000 Amp – Magnum SB, electrically operated, shunt trip, with RMS 1150 LSIG trip.

E. Each main and tie insulated case circuit breaker shall be equipped with a tripping system consisting of three current sensors, true RMS microprocessor-based trip unit and flux-transfer shunt trip. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The trip unit shall be equal in all aspects to Eaton type Digitrip RMS 520MC.

F. The trip unit shall be provided with an Arcflash Reduction Maintenance System. The Arcflash Reduction Maintenance System shall allow the operator to enable a maintenance mode using a 5-position switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. A blue LED on the trip unit shall indicate the trip unit is in maintenance mode. The use of zone selective interlocking to emulate this feature does not meet the intent of these specifications and will not be accepted.

G. The trip unit shall have LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip. Provide battery backup for LEDs.

H. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug. The trip unit shall have selectable thermal memory for enhanced circuit protection.

I. Protective device coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

   1. Long delay pickup and time.

   2. Short delay pickup and time and include I2t settings.

   3. Instantaneous pickup.

   4. Ground fault current pickup and time and include I2t settings or ground alarm only.

J. The trip unit shall have provisions for a single test kit to test each of the trip functions.

K. The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination where indicated on contract documents. If provided, the factory shall wire the zone interlocking system.

L. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale.

M. The trip unit shall have provisions for connection to the client's remote monitoring and control network. All monitored parameters and breaker status shall be transmitted in industry standard proto.

2.07 METERING

A. Provide solid state metering, complete with current transformers and potential transformers.

B. The metering shall be Cutler Hammer PMX 2270, CT's, with display.

2.08 SURGE PROTECTIOS

A. External surge protection shall be provided. Refer to Section 16011 for a description.

2.09 ENCLOSURE

A. External Enclosure shall be NEMA 12.

2.10 NAMEPLATE

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background or white characters on black background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.11 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. The color and finish of the Nema 1 switchboards shall be ANSI 61 light gray.

2.12 ARC FLASH WARNING LABEL

A. The switchboard shall be furnished with an appropriate Arc Flash Warning Label that complies with the NEC.

PART III - EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to ensure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground.

B. The manufacturer shall provide six (6) certified copies of factory test reports.

3.02 MANUFACTURER'S CERTIFICATION

A. A certified test report of all standard production tests shall be available to the Engineer upon request.

3.03 TRAINING

A. The Contractor shall provide a training session for up to four (4) owner's representatives at a job site location determined by the owner. A manufacturer's qualified representative shall conduct the training session. The training program shall consist of instruction on operation of the assembly, circuit breakers, fused switches, and major components within the assembly.

3.04 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code.

B. Contractor shall provide a concrete housekeeping pad for the switchboard. The switchboard assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to Contractor supplied floor sills to be set level in concrete per manufacturer's recommendations. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.05 FIELD ADJUSTMENTS

A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device

evaluation study and protective device coordination study.

B. Necessary field settings of devices, adjustments, and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Furnish and install disconnect switches and enclosed circuit breakers as indicated on the PLANS and specified herein. All switches are to be NEMA Rated Heavy Duty Type HD, fused or non-fused and UL Listed.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 REFERENCES

Federal Specification WS 865c

Federal Specification W-C-375B/GEN 21a

NEMA Standard AB1-1975

NEMA Standard KS1-2013

UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations

UL 98 Enclosed and Dead Front Switches

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300, "Submittals".

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 (NOT USED)

1.08 DELIVERY STORAGE AND HANDLING

A. In accordance with Section 16010.

1.09 (NOT USED)

1.10 WARRANTY

A. Manufacturer shall provide a one year warranty from the time manufacturer's start-up services are completed or 18 months from date of shipment whichever is later. Warranty shall include all parts and labor to troubleshoot and replace failed devices.

1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Furnish units manufactured by General Electric, Square D or Eaton.

2.02 MATERIALS/CONSTRUCTION

A. Fused and Non-fused Disconnect Switches

1. All switches are to have switch blades which are fully visible in the "OFF" position when the door is open. Switches are to be of dead-front construction with permanently attached arc suppressers hinged or otherwise attached to permit easy access of line-side lugs without removal of the arc suppresser. Lugs to be front removable and U.L. listed for copper cables. All current-carrying parts to be plated through electrolytic processes. Each switch to have a grounding lug for equipment ground wire connection rated for 75 degree C copper.

2. Switches to have load-break, quick-make and quick-break operating mechanism. Switches shall be provided with provisions for padlocking:

   a. In the off position only if the switch is a primary mean of disconnect for the facility, located on the utility side of the load,

   b. In either position if the switch is a secondary mean of disconnect for the facility located on the utility side of the load, given a primary switch with padlock in the off position only has been provided upstream.

3. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible.

4. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door in an "ON" position or closing of the switch mechanism with the door open. Switches shall be horsepower rated for 250 Volts AC or DC or 600 Volts AC as required for their service. All switches shall meet the requirement and fuse ratings as shown on drawings.

5. Fuses shall be equal to Bussman or Chase-Shawnut, or approved equal, dual element type. Size shall be as shown on drawings.

B. Enclosed Circuit Breakers

1. Construction

   a. Circuit breakers to have quick-make and quick-break, trip-free type operating mechanism with inverse time thermal trip and instantaneous time magnetic trip. Provide overload tripping elements in each pole. A tripped condition to be indicated by the breaker assuming a neutral position between "ON" and "OFF".

b. Circuit breaker shall have handles with provision for padlocking in the ”OFF” position, with at least four padlocks. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible. Multi-pole breakers to be common trip with a single trip handle; handle ties are NOT TO BE USED. Circuit breakers shall have a dual enclosure interlock to prevent unauthorized opening of the enclosure door when the circuit breaker is in the "ON" position, or closing of the circuit breaker mechanism with the door open. All current-carrying parts to be plated through electrolytic processes.

c. Furnish lugs to terminate the incoming/outgoing field wiring as shown on the PLANS. Refer to the PLANS. Each switch to have a grounding lug for equipment ground wire connection. Lugs to be front removable and U.L. listed for copper cables.

d. Circuit breaker shall consist of two (2) Form C auxiliary dry contacts. Each such contact shall be integral to the breaker and shall be mechanically interlocked with the breaker position. With the breaker in the open or tripped position, one contact in the Form C assembly shall be open and the other closed. Each contact shall change to the opposite state only when the breaker position changes from open/tripped to closed or from closed to open/tripped. Each contact shall be rated at 120 Volts AC, and capable of continuously driving up to a minimum of 5 Amp inductive load.

2. Circuit Breaker Ratings

a. Enclosed circuit breakers shall be thermal magnetic molded case circuit breakers with U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than the minimum RMS symmetrical short circuit current rating of the line-side (source) bus at 480 Volts AC unless otherwise indicated on the one-line diagram drawings (refer to the PLANS). Breakers shall operate continuously, without tripping, when operating/running current is equal to 80 percent of the long time trip setting (or frame rating, as applicable) of the breakers.

b. Circuit breaker shall be three pole, 600 Volt with a maximum continuous current carrying capacity as shown on the PLANS and as described in these specifications. Circuit breaker shall have a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than the minimum RMS symmetrical short circuit current rating of the line-side (source) bus at 480 Volts AC, unless otherwise indicated on the one-line diagrams shown on the PLANS. Breaker shall be U.L. listed and shall comply with NEMA Standard No. AB1-1975 and Federal Specification W-C-375B/GEN 21a. Circuit breaker shall be fully rated and not require de-rating for ambient temperatures of 40 degrees Celsius or less.

c. Furnish current limiting type circuit breakers when specifically required by the one-line drawings shown on the PLANS.

d. Provide electronic trip attachment where specifically shown on the PLANS. Trip unit shall be solid state type with adjustable long time, short time, instantaneous, ground fault and pick up settings as manufactured by "Square D" Micrologic LSIG Series B Trip Unit and Internal Ground Fault Protection, or approved equal.

e. Circuit breakers shall be Square D Company Type FCL or approved equal by General Electric Company "G.E." and Eaton.

C. Identification

1. In accordance with Section 16011.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 – 3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Install disconnect switches / enclosed circuit breakers at 4'-6" above finished floor and 3'-0" above finished grade outdoors unless otherwise noted on the PLANS.

B. Enclosed circuit breaker assemblies installed in ALL AREAS shall be enclosed in NEMA 4X 316 stainless steel corrosion resistant and gasketed cabinet. Exception: Enclosed circuit breaker assemblies installed inside the environmentally and climate controlled room shall be enclosed in NEMA 12 gasketed cabinet, the rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. Enclosed circuit breaker assemblies housed in NEMA 12 enclosures shall have ANSI #61 Gray finish.

C. All mounting hardware shall be 316 stainless steel.

3.04 REPAIR/RESTORATION

A. In accordance with Section 16010.

3.05 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Furnish and install transformers as indicated on the PLANS.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

B. The PLANS designate the size, rating, and other requirements.

1.03 REFERENCES

A. The following standards shall apply as if written here in their entirety:

ANSI 506	Specialty Transformers
NEMA ST 20	Dry-Type Transformers for General Applications
NFPA 70	National Electrical Code

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300, "Submittals".
   1. Submit a letter certifying full and complete compliance with the SPECIFICATIONS, PLANS and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 (NOT USED)

1.08 DELIVERY STORAGE AND HANDLING

A. As specified in Section 16010.

1.09 (NOT USED)

1.10 WARRANTY

A. Manufacturer shall provide a one year warranty from the time manufacturer's start-up services are completed or 18 months from date of shipment whichever is later. Warranty shall include all parts and labor to troubleshoot and replace failed devices.

1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are ABB, Eaton, General Electric and Square D.

2.02 MATERIALS/CONSTRUCTION

A. Enclosure
   1. Heavy gauge sheet steel with ventilation openings designed in accordance with U.L., NEMA and the NEC. Phosphatized, primed and finished with gray baked enamel or as indicated on the PLANS.

B. Wiring compartment
   1. Locate the wiring compartment below the core and coil. Have the compartment cooled by air circulation or insulated from the core and coil with a suitable thermal barrier.

C. Transformers shall be provided with integrated vibration insulation to completely isolate the core and coil assembly from the transformer enclosure.

D. Provide transformer nameplates of type 316 stainless steel, marked in accordance with NEC. Fasten nameplate to transformer with stainless steel screws or rivets.

E. Transformers located indoor shall be rated NEMA 1 unless indicated otherwise on the PLANS.

F. GROUNDING

   1. Core visibly grounded to enclosure by means of a flexible grounding conductor sized per NEMA, IEEE and ANSI standards.

G. SOUND LEVELS

   1. Sound levels shall be guaranteed not to exceed the following values when measured in accordance with NEMA ST 20-4.12:
      a. 45 dB for transformers rated 10-50 kVA
      b. 50 dB for transformers rated 51-150 kVA

2.03 FUNCTIONAL REQUIREMENTS

A. Manufacturer's standard quality ventilated dry type, 480 volts primary, 120/208 volts, 4 wire secondary, for 3 phase transformers, and 120/240 volt, 3-wire, secondary for single phase transformers. KVA rating and voltages shall be as shown on the drawings. Transformer shall be rated for 60 Hertz operation.

B. TAPS

1. Two (2) at 2-1/2% FCAN and two (2) at 2-1/2% FCBN.

C. 80 degree Celsius above 40 degree Celsius ambient. Insulating materials in accordance with NEMA ST 20 standards for a 220 degree Celsius U.L. component recognized insulation system.

D. CORE AND COILS

1. Continuous wound core impregnated with non-hygroscopic, thermosetting varnish. Core to be of high grade, non-aging silicon steel with high magnetic permeability. Core and coil bolted to base of enclosure but isolated from it by rubber vibration absorbing mounts. All windings shall be copper windings. Aluminum windings shall not be acceptable. The windings shall be treated to resist the effect of moisture.

2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Utilize flexible conduit for the last 1' to minimize vibration.

3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. CABLE CONNECTIONS

1. Make transformer cable connections with compression-type lugs suitable for termination of 75 degree C rated conductors. Position lugs so that field connections and wiring will not be exposed to temperature above 75 degree C.

B. FLOOR MOUNTING

Construct concrete pad for floor-mounted transformers:

1. Install minimal 4" thick housekeeping concrete pad with chamfered edges for indoor and outdoor floor-mounted equipment.

2. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3" beyond equipment.

3. Trowel pads smooth and chamfer edges to a ¾" bevel.

4. Provide dowels in slab, and rebar between the dowels. Add rebar mat in housekeeping pad with #4 rebar at 12" centers.

5. Secure equipment to pads with 316 stainless steel hardware.

6. Follow structural detail where applicable.

7. Maintain a minimum of 6" free air space between enclosure and walls.

C. WALL MOUNTING

1. Securely anchor type 316 stainless steel mounting brackets to the wall to provide adequate transformers support.

2. Provide vibration isolation for mounting the transformers.

3.04 REPAIR/RESTORATION

A. In accordance with Section 16010.

3.05 – 3.07 (NOT USED)

3.08 TESTING AND INSPECTION

A. In accordance with Section 16950.

3.09 STORAGE, HANDLING AND PROTECTION

A. In accordance with Section 16010.

3.10 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

PART I - GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers.

1.02 RELATED REQUIREMENTS

A. Section 16010 – Electrical General Provisions

B. Section 160120 – Motor Control Centers

1.03 ABBREVIATIONS AND ACRONYMS

A. IGBT: Insulated gate bipolar transistor

B. PID: Proportional-integral-derivative

C. PWM: Pulse width modulation

D. VFD: Variable-frequency drive

1.04 DEFINITIONS

A. Variable-frequency motor controllers may also be identified as VFDs, AFDs, variable-frequency drives, or adjustable-frequency drives.

1.05 REFERNCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

B. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components; 2010, with Editorial Revision (2015).

D. IEC 60068-2-78 - Environmental Testing – Part 2-78: Tests – Test Cab: Damp Heat, Steady State; 2012.

E. IEC 60146-1-1 - Semiconductor Converters – General Requirements and Line Commutated Converters – Part 1-1: Specification of Basic Requirements; 2009.

F. IEC 60204-1 - Safety of Machinery – Electrical Equipment of Machines – Part 1: General Requirements; 2016, with Amendments (2021).

G. IEC 60255-149 - Measuring Relays and Protection Equipment – Part 149: Functional Requirements of Thermal Electrical Relays; 2013.

H. IEC 60364-1 - Low-Voltage Electrical Installations – Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions; 2005.

I. IEC 60447 - Basic and Safety Principles for Man-Machine Interface, Marking and Identification – Actuating Principles; 2004.

J. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

K. IEC 60664-1 - Insulation Coordination for Equipment Within Low-Voltage Supply Systems – Part 1: Principles, Requirements and Tests; 2020.

L. IEC 60721-3-3 - Classification of Environmental Conditions – Part 3-3: Classification of Groups of Environmental Parameters and Their Severities – Stationary Use at Weatherprotected Locations; 2019.

M. IEC 60947-2 - Low-Voltage Switchgear and Controlgear – Part 2: Circuit-Breakers; 2019, with Amendments (2019).

N. IEC 61000-3-12 - Electromagnetic Compatibility (EMC) – Part 3-12: Limits – Limits for Harmonic Currents Produced by Equipment Connected to Public Low-Voltage Systems with Input Current >16 A and ≤75 A per Phase; 2011, with Amendments (2021).

O. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test; 2008.

P. IEC 61000-4-5 - Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test; 2014, with Amendment (2017).

Q. IEC 61439-1 - Low-Voltage Switchgear and Controlgear Assemblies – Part 1: General Rules; 2020.

R. IEC 61508-1 - Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems – Part 1: General Requirements; 2010.

S. IEC 61800-5-1 - Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy; 2022.

T. IEC TS 60034-25 - Rotating Electrical Machines – Part 25: AC Electrical Machines Used in Power Drive Systems – Applications Guide; 2022.

U. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems; 2022.

V. ISO 13849-1 - Safety of Machinery – Safety-Related Parts of Control Systems – Part 1: General Principles for Design; 2015.

W. ISO 13849-2 - Safety of Machinery – Safety-Related Parts of Control Systems – Part 2: Validation; 2012.

X. ISO 9001 - Quality Management Systems — Requirements; 2015.

Y. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015.

Z. NEMA ICS 4 - Application Guideline for Terminal Blocks; 2015.

AA. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2020.

BB. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2022.

CC. NEMA MG1 – Motors and Generators; 2021

DD. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

EE. NFPA 79 - Electrical Standard for Industrial Machinery; 2021.

FF. SEMI F47 - Specification for Semiconductor Processing Equipment Voltage Sag Immunity; 2006 (Reapproved 2012).

GG. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

HH. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.

II. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordinate work to provide VFDs suitable for use with driven equipment.

B. Preinstallation Meeting: Review material selections and installation procedures with manufacturer's representative and affected installers.

C. Scheduling: Do not schedule functional demonstration testing until operational readiness testing is complete and associated report and certification have been submitted.

1.07 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittal procedures.

B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.

C. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets for variable frequency drives, enclosures, components, and accessories.

1. Indicate rated input kVA and output kVA or HP, topology, converter/inverter type, percent efficiency, and operating/electrical characteristics.

2. Include maximum Btu (kJ) heat release data and ambient cooling requirements.

E. Shop Drawings: Indicate enclosure dimensions, shipping section dimensions, weights, foundation requirements, required clearances, location and size of each field connection, and mounting and installation instructions.

1. Include project-specific elementary and interconnection diagrams for power, signal, control, and communications wiring that provide minimum detail shown for drawings in NFPA 79 appendix.

2. Include electronic 2D dimensional drawings and 3D model CAD files for standard units upon request.

F. Seismic Qualification Certification:

1. Certificate of compliance.

2. Dimensioned equipment outline drawing identifying center of gravity and mounting/anchoring provisions.

3. Details and installation requirements of equipment anchorage devices on which certification is based.

G. Harmonic Performance Certification: Provide manufacturer's statement of compliance with IEEE 519 based on detailed electrical power system diagram

provided by Owner.

H. Derating calculations.

I. Factory acceptance testing report.

J. Operational Readiness Report:

1. Document test results, including assumptions, conditions, allowances, and corrections made.

2. Provide listing of field modifications and adjustments made including settings/parameters not identified as factory defaults within equipment's operations and maintenance manual documentation.

3. Include certification, signed by Contractor, that equipment and associated system have been installed, configured, and tested in accordance with manufacturer's recommendations, conforms to requirements of Contract Documents, and is ready for operation.

K. Functional Demonstration Testing Report: Document test results, including assumptions, conditions, allowances, and corrections made.

L. Manufacturer's qualification statement.

M. Installer's qualification statement.

N. Operation and Maintenance Data:

1. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

a. Include manufacturer, supplier, support, and repair center contact information.

b. Include manufacturer's standard operation and maintenance data assembled for each size and type of equipment furnished.

c. Include contact information for parts stocking location closest to Owner.
d. Include list of furnished and recommended spare parts.

e. Identify critical spare parts associated with long lead times and/or those critical to unit operation.

f. Identify maintenance spare parts required to regularly perform scheduled equipment maintenance including, but not limited to, consumable parts required to be exchanged during scheduled maintenance periods.

2. Submit prior to equipment arrival on site.

O. Project Record Documents:

1. Construction, installation, schematic, and wiring diagrams updated to as-installed and commissioned state.

2. Configured settings/parameters for adjustable components updated to as-installed and commissioned state, noted if different from factory default.

P. Executed warranty.

Q. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:

1. See Section 01730 – Product Requirements for additional provisions.

2. Spare Parts:

a. Provided on spare VFD per size, as shown in the Contract Documents, for the following equipment:

1) Blower (240A)

2) EQ Transfer Pump (14 FLA)

3) Mixer (21 FLA)

3. Tools: Manufacturer-specific special tools required to install, remove, test, and maintain motor controller components.

a. Equipment Configuration Files: For future upload into replaced/repaired components, in media format acceptable by Owner.

1.08 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70

2. Requirements of authorities having jurisdiction

3. Applicable local codes

B. Manufacturer’s Qualifications:

1. Firm engaged in manufacture of specified products of types and sizes required,

and whose products have been in satisfactory use in similar service for minimum of 10 years.

2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.

3. Service, repair, and technical support services available 24 hours per day, 7 days per week from manufacturer or their representative.

4. Certified in accordance with ISO 14001.

C. Installer Qualifications: Firm with minimum 10 years experience with motor controllers of similar type and scope.

D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.

B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.

C. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.

D. Inspect products and report concealed damage or violation of delivery, storage, and handling requirements to Engineer.

1.10 FIELD CONNECTIONS

A. Maintain field connections within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

A. See Section 017800 – Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 12 months from date of commissioning or 18 months from

date of shipment, whichever comes first. Complete forms in Owner's name and register with manufacturer.

PART II – PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric; Altivar Process ATV600

B. ABB

C. Eaton

D. Source Limitations: Furnish products produced by manufacturer of other electrical distribution equipment for project.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Basis of Design: Schneider Electric; Altivar Process ATV600

B. Standard Drive Units

1. Noncombination drive controller capable of feeding 3-phase synchronous and asynchronous motors.

2. Design for fluid management processing and energy saving with extensive flexibility for water/wastewater, mining, minerals/metals, oil/gas, and food/beverage applications.

3. Design for wall and/or cabinet mounting.

4. Available in range of tested combinations for protection and short circuit interrupt ratings.

C. Compact Drive Systems

1. Combination enclosed drive controller with integrated enclosures for wall or floor mounting depending on size.

2. Provide circuit breaker disconnect and adequate room for power peripherals, including isolation and bypass contactors, within same enclosure.

3. Available with full range of standard and engineered options for various application requirements.

4. Utilize standard drive unit as power converter.

D. Description: Digitally controlled drive using pulse width modulation (PWM) for starting and speed control of standard IEC or NEMA MG 1 design, AC inverter-

duty asynchronous motors and synchronous motors with permanent magnets by adjustment of output voltage and frequency.

E. Unless otherwise indicated, match VFD to load (variable or constant torque) and actual motor being controlled considering speed, current, kVA, and inrush requirements.

F. General Requirements:

1. List and label as complying with UL 508 or UL 61800-5-1

2. Comply with:

a. IEC 60068-2-78.

b. IEC 60146-1-1.

c. IEC 60664-1.

d. IEC 60447.

e. IEC 61439-1.

f. IEC 60364-1.

g. IEC 60204-1.

h. IEC 60529.

i. IEC 61000 (SERIES).

j. IEC 61800 (SERIES).

k. IEC 60721-3-3.

l. IEC 60255-149.

m. IEC 61000-4-2.

n. NEMA ICS 4.

o. NEMA ICS 7.

3. Sustainability

a. Provide products designed for sustainable performance with available documentation on regulatory compliance, material content, environmental impact, and circularity attributes including, but not limited to:

1) Compliance with RoHS and REACh directives.

2) Product environmental profiles (PEPs).

3) Product end-of-life instructions.

b. Component Materials: Recyclable, nontoxic, and flame retardant.

c. Product Recyclability Rate: Greater than 70 percent.

d. Comply with IEC 62635 guidelines to reduce carbon footprint, with available documentation of product carbon footprint.

4. Environmental Requirements:

a. Rated to withstand the following environmental conditions while providing 100 percent output current continuously:

1) Storage Temperature: From minus 40 degrees F (minus 40 degrees C) to 158 degrees F (70 degrees C).

2) Operating Temperature:

(a) UL 50E Type 1: From 5 degrees F (minus 15 degrees C) to 122 degrees F (50 degrees C) without derating, up to 140 degrees F (60 degrees C) with derating of power stage.

(b) Enclosed: From 14 degrees F (minus 10 degrees C) to 104 degrees F (40 degrees C) without derating, down to 14 degrees F (minus 10 degrees C) with enclosure heater, up to 131 degrees F (55 degrees C) with derating of power stage.

3) Relative Humidity: Between 0 and 95 percent without condensation in accordance with IEC 60068-2-78.

4) Operating Altitude: Up to 3,280 feet (1000 m) without derating, up to 15,748 feet (4800 m) with derating.

5) Corrosion Protection Level: IEC 60721-3-3, Class 3C3 for cooling air and chemical gases.

6) Biological Protection Level: IEC 60721-3-3, Class 3B1.

7) Dust Protection Level: IEC 60721-3-3, Class 3S3.

8) Vibration and Shock Protection Level: IEC 60721-3-3, Class 3M3.

b. Derating: Provide derating factor as required in accordance with environmental conditions to prevent degradation of unit lifetime, performance, overload capability, or reliability.

c. Enclosure:

1) Integral Enclosure: UL 50E Type 12, unless otherwise indicated.

2) User Interface Terminal: UL 50E Type 12, mounted on front face of enclosure, and accessible for programming and controls with main door closed.

3) Provide front-accessible cabinet constructed in accordance with IEC 60439-1.

4) Provide bottom conduit entry to allow for top mounted cooling components.

5) Provide forced-air and heat-sink cooling system that does not require liquid or air condition cooling components for ambient temperatures within drive's stated ambient temperature operating range.

G. Performance Requirements:

1. Provide normal duty rating unless otherwise indicated.

2. Normal Duty:

a. Overload Capability: Allow 110 percent current overload for one minute.

b. Overtorque Capability: Allow 110 percent of rated motor torque during 60 seconds, every 10 minutes.

3. Input Voltage Tolerance: Plus 10 percent/minus 15 percent of nominal input voltage range.

4. Rated Frequency: 50 Hz to 60 Hz, plus/minus 5 percent.

5. Displacement Power Factor: 0.97, minimum.

6. Harmonics Mitigation:

a. Compact Drive Systems

1) Available Ratings: 100 hp and below at 460 VAC.

2) Provide integral impedance of 3 percent, minimum, for current total harmonic distortion (THD-I) less than 48 percent at 80 to 100 percent load in accordance with IEC 61000-3-12.

3) Provide 6-pulse bridge rectifier design with additional line reactors integral to enclosure for total equivalent impedance of 5 percent, minimum, and current total harmonic distortion (THD-I) less than

26 percent at 100 percent load.

b. Low Harmonic Compact Drive Systems With Passive Harmonic Filter

1) Available Ratings: 100 hp and below at 460 VAC.

2) Provide 6-pulse bridge rectifier design with integral dedicated harmonic filter including contactor for capacitor control.

3) Current Total Harmonic Distortion (THD-I): Less than 5 percent.

7. Efficiency

a. Compact Drive Systems: Greater than 97.5 percent at nominal load.

b. Low Harmonic Compact Drive Systems with Passive Harmonic Filter: Greater than 96 percent at nominal load.

8. Surge Immunity: IEC 61000-4-5, Level 3

9. Comply with SEMI F47 for degraded running operation during undervoltage conditions.

a. 50 percent undervoltage for up to 200 milliseconds.

b. 30 percent undervoltage for up to 500 milliseconds.

c. 20 percent undervoltage for up to 1 second.

10. Speed Range:

a. Motor Quadrant: 1:100 in sensorless vector control.

b. Generator Quadrant: 1:50 in sensorless vector control.

11. Speed Accuracy: plus/minus 10 percent of nominal motor slip in sensorless vector control.

12. Torque Control Accuracy: plus/minus 15 percent in sensorless vector control for AC motors.

H. Application Requirements

1. Supported Motor Control Types:

a. Volts per hertz vector control, standard.

b. Volts per hertz vector control, 5 points.

c. Volts per hertz vector control, quad.

d. Synchronous motor control.

e. Volts per hertz vector control, energy savings.

2. Provide real time clock management with battery backup.

3. Support automatic tuning of motor parameters through measurement of motor without rotation, and without disconnection of load from motor.

4. Provide functionality adjustable within drive parameters to reduce voltage surges on motor cables.

5. Voltage Reflection Suppression: Provide AC chokes and filters as required for installation and motor requirements.

   a. Motors Complying with IEC TS 60034-25 or NEMA MG 1 Part 31:

      1) Unshielded Motor Cable Length up to 500 feet (150 m): Manage with VFD functionality.

      2) Unshielded Motor Cable Length up to 1,000 feet (300 m): Provide AC choke.

      3) Unshielded Motor Cable Length up to 1,640 feet (500 m): Provide dV/dt filter.

      4) Unshielded Motor Cable Length up to 3,280 feet (1000 m): Provide sinus filter.

   b. Motors not Complying with IEC TS 60034 or NEMA MG 1 Part 31.

      1) Unshielded Motor Cable Length up to 164 feet (50 m): Provide dV/dt filter.

      2) Unshielded Motor Cable Length up to 3,280 feet (1000 m): Provide sinus filter.

6. Protection:

   a. Listed as complying with UL 508 or UL 61800-5-1 for use on distribution systems.

   b. Short Circuit Current Rating:

      1) Coordinated in accordance with UL 61800-5-1 and NEMA ICS 7.1.

      2) Minimum Short Circuit Current Rating:

         (a) Compact Drive Systems: 100 kA

c. Micro-Short Voltage Sag Immunity: Comply with SEMI F47.

d. Upon power-up, automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, DC to DC power supply, control power, and precharge circuit.

e. Protect against short circuits between output phases and ground, and logic and analog outputs.

f. Provide selectable ride through function enabling logic to maintain control for minimum of one second without tripping.

g. Deceleration Mode: Programmable for normal and trip conditions.

h. Stop Modes: Freewheel stop, fast stop.

i. Upon loss of analog process follower reference signal, trip and/or operate at user-defined speed set by software programmed speed settings or last speed.

j. Integrate protection against IGBT and heat sink overtemperature.

k. Solid State Thermal Protection: Listed as complying with IEC 61800-5-1, Class 10 overload protection; comply with IEC 60947-2.

l. Provide motor thermal memory retention function.

m. Support protection of motor with temperature probes connected.

n. Support limiting motor surge to twice DC bus voltage.

o. Provide internal error detection.

p. IGBT Protection:

    1) Overcurrent protection.

    2) Checkup sequence.

    3) Checkup sequence before PWM enable sequence.

    4) Overheat protection.

q. Current Protection:

    1) Phase short circuit protection.

    2) Ground protection.

    3) Overcurrent protection.

r. Voltage Error Protection:

1) Mains overvoltage protection.

2) Mains undervoltage protection.

3) DC bus overvoltage protection.

4) DC bus precharge protection.

s. Thermal Protection:

1) Overtemperature protection.

2) Fan management.

3) Switching frequency management.

t. Motor Protection Functions:

1) Motor output phase detection.

2) Motor surge voltage.

3) Motor overload detection.

4) Motor stall protection.

u. Application Protection Functions:

1) Catch-on-fly function.

2) Mains input phase lost protection.

3) Motor overspeed input protection.

4) Current limitation.

5) Power limitation.

6) Reverse inhibition.

7) Underload protection.

8) Overload protection.

9) External error management.

10) Loss of follower signal.

11) Thermal sensor management.

12) PID feedback.

13) Customer-defined input.

I. Control and Interface Requirements:

1. Indicators:

a. LED near connection point of device that displays when hazardous voltage is present.

b. Three LEDs for local diagnostics.

c. Three dual-color LEDs for embedded communication status.

d. Four dual-color LEDs for optional communication status.

2. User Interface:

a. Provide detachable UL 50E Type 12/IEC 60529 IP65 rated bi-color backlit graphical user interface terminal with keypad and capacitive wheel for monitoring, annunciation, and configuration. Change graphical display to red backlit color when alarm occurs.

b. Door-mount interface with 7/8 inch (22 mm) hole.

c. Provide "Simply Start' menu for commissioning; provide accessible parameter setting with plain text messaging and actual setting range.

d. Support password protection via keypad.

e. Support saving and downloading VFD configurations and porting them to other VFDs.

f. Provide mini-USB port for mass storage or PC device connection.

g. Self-Diagnostic Capabilities: Display alarms, errors, and warnings as they occur and store minimum of 15 last messages in memory; accessible by PC maintenance tools or web server with flash record for data logging expertise.

h. Utilize identical user interfaces throughout power range to avoid user confusion and need for training in several different units.

i. Display messages in plain text; support multiple languages including English, French, and Spanish.

j. Provide QR code or equivalent for access to enhanced diagnostics, documentation, and customer service.

3. Control Interface:

a. Interface with automation systems to monitor, control, display, and record data for use in processing reports. Retain settings within nonvolatile memory.

b. Speed Command and Reference Control Sources:

    1) I/O terminals.

    2) Communication network.

    3) Web server.

    4) Remote graphic display terminal.

c. Inputs/Outputs:

    1) Analog Inputs: Two programmable 0(4)-20 mA or 0-10 VDC.

        (a) Two analog inputs also programmable for temperature sensors (PTC, PT100, PT1000, KTY84).

    2) Analog Outputs: Two programmable 0(4)-20 mA or 0-10 VDC.

    3) Discrete Inputs: Six programmable isolated logic inputs, sink or source.

        (a) Two discrete inputs also programmable as 0-30 kHz pulse inputs.

        (b) Two discrete inputs dedicated for safe torque off safety function in accordance with IEC 61508-1 SIL3.

    4) Discrete Outputs: Three programmable relay contacts

        (a) One discrete output dedicated to product watchdog logic.

d. Programmable Analog Input Available Assignments:

    1) Speed reference.

    2) Summing reference.

    3) Subtracting reference.

    4) Multiplying reference.

    5) Torque reference.

    6) Torque limitation.

    7) PID feedback.

8) Manual PID reference.

9) PID speed reference.

10) Forced local reference

e. Programmable Analog Output Available Assignments:

1) Motor current.

2) Motor frequency.

3) Motor torque, signed or unsigned.

4) Motor power.

5) Motor voltage.

6) Output frequency, signed or unsigned.

7) PID error.

8) PID feedback.

9) PID output.

10) PID reference.

11) Ramp output.

12) Signed ramp.

13) Drive thermal state.

14) Motor thermal state.

15) Pressure sensor.

16) Flow sensor.

f. Programmable Discrete Input Available Assignments:

1) Run.

2) Forward.

3) Reverse.

4) Jog.

5) Preset speeds.

6) Reference switching.

7) Ramp switching.

8) Error reset.

9) Error inhibition.

10) Product reset.

11) PID regulation mode, auto.

12) PID speed regulation mode, manual.

13) PID integral reset.

14) Preset PID reference.

15) Sleep/wake-up.

16) Activate sleep mode by flow detection.

17) Analog torque limitation activation.

18) Torque reference sign.

19) Command switching.

20) Parameter sets selection.

21) Fast stop.

22) DC injection.

23) Freewheel stop.

24) Plus speed.

25) Minus speed.

26) External error.

27) Prefluxing.

28) Forced local control.

29) Current limitation activation.

30) Output contactor feedback.

31) Reference memorization.

32) Auto-tuning.

33) Forced operation.

34) Underload detection.

35) Overload detection.

36) Limiting low speed operating time.

37) Switching frequency, noise reduction.

38) Drive lock assignment.

39) Outlet pressure switch select.

40) Pipe fill.

41) External anti-jam trigger.

42) Dry running/no flow switch select.

43) Pump low flow/no flow switch select.

g. Programmable Discrete Output Available Assignments:

1) Ready.

2) Drive running.

3) Frequency reference attained.

4) Current attained.

5) High speed attained.

6) Drive error.

7) Frequency threshold attained.

8) Torque sign.

9) Motor thermal state attained.

10) Drive thermal state attained.

11) Torque or current limitation attained.

12) Output contactor command.

13) Input contactor command.

14) Current present.

15) Power removed.

16) Alarm groups.

17) Alarms: Load slipping, 4-20 mA loss, brake control, external error, PTC, PID error, PID feedback, IGBT temperature, undervoltage, torque control, drive temperature, braking resistor, fan counter, fan feedback, customer warning, power threshold, and electrical power drift.

18) Active configuration.

19) Active parameter set.

20) Active channel.

21) DC bus charged.

22) DC bus charging.

23) Water Command: Jockey pump, priming pump.

24) Water Running: Anti-jam, pipe fill, priming pump, and jockey pump.

25) Water Warning: Dry running, flow, inlet pressure, outlet pressure, pump cycling, anti-jam, and outlet pressure switch.

h. Safety Inputs:

1) Two inputs dedicated to safe torque off (STO) safety function, which prohibits unintended equipment operation, in accordance with IEC 61508-1 SIL3.

2) Comply with ISO 13849-1 and ISO 13849-2 (PL e).

3) Manufacturer to provide certified schematics and list of devices to comply with IEC 60204-1 stopping category 0 and 1.

4) Integrate safety contacts in accordance with EN-81 (SERIES).

4. Communications:

   a. Provide one Modbus and one Ethernet Modbus TCP communications port.

   b. Provide the following as required for communications:

      1) Ethernet IP or Modbus TCP, RJ45 dual port for daisy chain.

   c. Ethernet Ports: Comply with IPv6, provide capability for web server access and network management via SNMP and clock synchronization.

   d. Embedded Web Server:

      1) Support enhanced diagnostic, mini usb, parameter access, and energy management.

      2) Support creation of user-defined custom dashboard for viewing drive and process status through tables, charts, and graphical views.

      3) Support export of data in standard table format using web server, for energy consumption information and error/warning history.

   e. Comply with Cyber Security Management ISA Secure/Achilles.

   f. Capable of providing Wi-Fi connectivity for wireless diagnostic, configuration, and parameter access.

   g. Provide communications modules[capable of being] remotely powered by separate external 24 VDC source for continued communications with drive power supply off.

   h. Integration Connectivity:

      1) DHCP protocol for fast device replacement.

      2) DTM library in accordance with standard FDT technology.

5. Configuration:

   a. Support independent command and speed reference signals from:

      1) Terminals.

      2) Modbus port.

      3) Ethernet port.

4) Communication option card.

5) Keypad display.

b. Speed Setpoint Function:

1) Maximum output frequency function.

2) Low and high speed scaling and limitation function.

3) Jump frequency.

4) Speed summing references function.

5) Preset-speed references function.

6) Jog function.

7) Up-down speed references.

c. Stop Function:

1) Deceleration ramp on power loss.

2) Freewheel stop.

3) Stop by DC injection at motor stop detection.

4) Stop by DC injection by logic input.

5) Stop on deceleration ramp adaptation.

d. Accelerating/Deceleration, Time-Adjustable Ramp Function:

1) Ramp Type: Linear ramp, S shape ramp, with U or customized profile.

2) Ramp deceleration adaptation.

3) Ramp switching.

e. Application Programming Dedicated to Pumps:

1) Pump Control and Monitoring Functions:

(a) Centrifugal pump characteristics and configurations.

(b) Pump Monitoring Function: Define data relevant for pump including acceleration, low speed, and high speed.

(c) Application Units Function: Define units used in applications.

(d) Pump Cyclic Start Protection: Protect pump against excessive restarts in dedicated time period.

(e) Multi-pump functions.

2) Pump Protection Functions:

(a) Anti-Jam Function: Remove automatically clogging substances from pump impellers.

(b) Pipe Cleaning Function: Start pump regularly to avoid sedimentation in pump impeller.

(c) Cavitation pump protection.

(d) Inlet protection to avoid system dry running.

3) Application Control Functions:

(a) Stop-and-Go Function: Reduce consumption in standby mode.

(b) Pulse input to connect flow meter.

(c) Process Control (PID) Function: Maintain process at given pressure or flow reference.

(d) Flow Limitation Function: Limit consumption of water.

(e) Friction Loss Compensation Function: Compensate for pressure losses in pipes due to friction.

(f) Pipe Fill Function: Manage smooth control during pipe filling and lessen effects of water hammer.

(g) Sleep Wake-Up Function: Manage periods of application when process demand is low and when not needed.

(h) Low Demand Function: Define periods of application when process demand is low to save energy.

(i) Jockey Pump Control Function: Start jockey pump, during sleep period, to maintain emergency service pressure or demand including low water.

(j) Sensor Management: Define use to drive inputs to manage

pressure sensor or flow sensor.

4) Application Protection Functions:

(a) High Flow Protection Function: Detect pipe burst or detect running outside normal working area.

(b) Outlet Pressure Protection Function: Fix minimum and maximum pressure.

5) Pump Curve Input to Optimize Pump Performance:

(a) Input and storage of pump characteristics including five points of pump curve.

(b) Best Efficiency Point (BEP) Function: Run in optimum conditions and detect deviation from that point.

6. Diagnostics and Configuration:

a. Windows-Based PC Software: Support setting and modifying of parameters, controlling drive, reading actual values, and analyzing trends; support wired or wireless connection to VFD.

b. Display faults in plain text on help screens for troubleshooting; codes are not acceptable.

c. Provide real time clock management for time stamping of detected errors.

d. Display detected errors with QR codes for troubleshooting.

e. Provide LED lights to indicate VFD status.

f. Support dynamic display of I/O status.

7. Energy Management:

a. Data Logging Function: Keep files ready for maintenance or user.

b. Provide energy management information through web server, keypad, facet for SCADA, or communication networks.

c. Support display of energy efficiency and energy management chart.

1) Report in KW.

2) Energy History: Instant, weekly, monthly, and yearly.

3) Trend base on variation/time.

4) Power Measurement Accuracy: Less than 5 percent.

d. Support display of efficient set point for pump based on pump characteristics.

e. Support display of efficiency board including CO2 savings, savings viewer, and return of investment.

2.03 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Factory Acceptance Testing (FAT): Provide factory functional testing of VFDs prior to shipment.

PART III - EXECUTION

3.01 EXAMINATION

A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.

B. Examine for conditions detrimental to completion of work.

3.02 INSTALLATION

A. Install equipment in accordance with manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment , connections and adjustments, and testing of the assembly and components listed herein.

1. Manufacturer Services

a. Include necessary material, equipment, labor, and technical supervision.

b. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.

c. Identify motor controllers with label indicating inspection/testing agency and date of service

B. Operational Readiness Testing

1. Inspect and test equipment and associated systems for conformance to Contract Documents, including equipment manufacturer’s recommendations, and readiness for operation.

a. Visually inspect for physical damage and proper installation.

b. Perform tests in accordance with manufacturer's instructions.

c. Perform tests to verify compliance with Contract Documents.

d. Perform tests to verify equipment is ready for operation.

e. Touch-up paint chips and scratches with manufacturer-supplied paint.

3.04 FIELD TESTING

A. Calibrate VFD ramp up time and ramp down time.

B. Calibrate manual frequency set points.

C. Complete the attached VFD testing report.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01730 - Closeout Submittals for additional submittals.

B. Functional Demonstration Testing: Demonstrate proper operation of transformers and associated systems to Owner's designated representative and Engineer, observing and documenting compliance with Contract Documents.

C. Training:

1. Train Owner’s personnel on operation and maintenance of system.

a. Accommodate minimum of ten attendees.

b. Provide not less than one session(s) with four of classroom and hands-on training.

c. Training Reference: Use submitted operations and maintenance manuals.

d. Instructor: Factory-trained manufacturer's representative.

e. Location: Project site.

2. Provide sufficient time and detail in each session to cover the following at minimum:

a. Operation theory.

b. Major equipment components.

c. Equipment operation.

d. Equipment configurations.

e. Maintenance, troubleshooting, and repair.

f. Component-level parts replacement.

3.06 PROTECTION

A. Protect installed motor controllers from subsequent construction operations.

VFD
TEST REPORT

VFD NAME:_____ LOCATION: _____

MOTOR DATA:
MOTOR NO: _____
HP_____ FLA_____ VOLTAGE_____

AUTOMATIC MODE:

RAMP UP TIME (IN SECONDS):
SPECIFIED: _____ ACTUAL_____

MOTOR CURRENT:
A PHASE_____
B PHASE_____
C PHASE_____

FREQUENCY SET POINT: _____

PRESSURE.
EXPECTED:_____ ACTUAL_____

RAMP DOWN TIME (IN SECONDS):
SPECIFIED: _____ ACTUAL_____

Comments:

Notes:
1. PROVIDE PRESSURE READINGS FOR THE FOLLOWING EQUIPMENT:
   a. EFFLUENT TRANSFER PUMPS (LSPUMP-04/05/06)
   b. BLOWERS (BLOWER-01/02/03)
2. MIXERS SHALL BE TESTED AS REQUIRED BY MANUFACTURER.

LOCAL MANUAL MODE:

RAMP UP TIME (IN SECONDS):
SPECIFIED: _____ ACTUAL_____

MOTOR CURRENT:
A PHASE_____
B PHASE_____
C PHASE_____

FREQUENCY SET POINT: _____

PRESSURE
EXPECTED:_____ ACTUAL_____

RAMP DOWN TIME (IN SECONDS):
SPECIFIED: _____ ACTUAL_____

Comments:

Notes:
1. LOCAL SPEED CONTROL IS APPLICABLE FOR THE FOLLOWING EQUIPMENT ONLY:
   a. EFFLUENT TRANSFER PUMPS (LSPUMP-04/05/06)
2. MIXERS SHALL BE TESTED AS REQUIRED BY MANUFACTURER.

END OF SECTION

PART I - GENERAL

1.01 SCOPE OF WORK

A. Furnish and install solid state reduced voltage motor starters where indicated on the drawings.

1.02 SUBMITTALS

A. Submit shop drawing and product data for the products of this Section in accordance with contract documents. Comply with Section 01300.

B. Submit required copies of operation and maintenance (O&M) manuals in accordance with the contract documents. Include approved shop drawing data in the O&M manuals. Comply with Section 01730.

1.03 MANUFACTURER

A. SSRV shall be the same manufacturer as the motor control center

PART 2 - PRODUCTS

2.01 CONSTRUCTION

A. The solid-state starter shall be UL, cULus and CSA listed and bear the CE mark for compliance with applicable IEC and Euro Norm standards for solid-state reduced voltage motor starters. The solid-state reduced voltage starter shall be an integrated unit with power SCR's, heat sink, logic board, paralleling bypass contactor and electronic overload relay enclosed in a single molded housing. Each unit shall include a mainline fuse, HMCP motor circuit protector and line and load side surge arresters.

B. SCR based power section shall consist of six (6) back- to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1600 volts PIV. The starter shall be three-phase, 50 or 60 Hz, severe duty type rated for a minimum of 150% of the full load current of the motor load.

C. Units shall include an integrated fan controlled by thermal sensors on the heat sink. Fan shall automatically operate during the start ramp and if internal temperature on the heat sink exceeds 60-degree C. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt effects. The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns. The paralleling run bypass contactors shall energize when the motor reaches 90% of full speed and close/open under 1 times motor current.

D. The integral paralleling run bypass contactor shall utilize an intelligent oil controller to limit contact bounce and optimize coil voltage during varying system conditions.

E. Starter shall be provided with electronic overload protection as standard and shall be based on an inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad. Overload protection shall be adjusted via the device keypad and shall have a motor full load amp adjustment from 30 to 100% (3.2:1) of the max continuous ampere rating of the starter. Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad. Starter shall be capable of either an electronic or mechanical reset after a fault. Units using bi-metal overload relays are not acceptable. Overtemperature protection (on heat sink) shall be standard

F. Starters shall provide protection against improper line side phase rotations as standard. Starter will shut down if a line side phase rotation other than A-B-C exists. This feature can be disabled via a DIP switch on digital interface module.

G. Starters shall provide protection against a phase loss as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via a DIP switch on the digital interface module.

H. Starter shall provide protection against a motor stall condition during the start ramp as standard. This feature can be disabled via a DIP switch on the digital interface module.

I. Starter shall provide protection against a motor jam condition during run as standard. This feature can be disabled via a DIP switch on the digital interface module.

J. Starter shall be provided with a form C normally open (NO), normally closed (NC) contact that shall change state when a fault conditions exists. Contacts shall be rated 240V AC and 24V DC max, 3 amps as standard.

K. Starters shall be capable of both electronic and mechanical reset after a fault.

L. A 6-line display digital interface module shall be provided to program the starter Monitoring parameters shall include line currents, pole currents, pole voltages, number of starts and DC control voltage. In addition, an LED display on the device keypad shall indicate type of fault (Overtemp, Phase Loss, Jam, Stall, Phase Reversal, and Overload).

M. The following control function adjustments from the digital interface module shall be provided:

1. Selectable Torque ramp Start or Current Limit Start
2. Adjustable Kick Start Time, 0-2 seconds.
3. Adjustable Kick Start Torque, 0-80%.
4. Adjustable Ramp Start Time, 0.5 seconds – 12 minutes.
5. Adjustable Initial Starting Ramp Torque, 0-85%.
6. Adjustable Smooth Stop Ramp Time, 0-60 seconds.

N. Each starter shall be provided with a "pump control" module designed specifically for centrifugal pump applications.

O. Starters shall include a HMCP for short circuit protection and quick disconnect means. Starters and HMCPs are to be rated per UL508D for a withstand rating of 42 kAIC rms.

P. Control power shall be 24V DC as standard for safety and reliability. Separate control terminals shall be provided for 24V DC power, logic level signals for permissive, start, jog forward, ramp start overload override and electric reset. Control terminals shall be pull-apart for easy access and wiring. Optional external interface circuitry shall include 120-volt relay logic interface capability.

Q. One fully equipped spare starter shall be furnished for each type supplied.

R. Starters shall be equipped with Eaton or equal surge protection modules on both the line and load sides.

S. Starters shall have a 3-contactor bypass arrangement.

T. Starters shall be equipped with a solid-state overload as shown.

PART 3- EXECUTION

3.01 INSTALLATION

A. Motor starters shall be installed in the motor control center.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

Furnish and install lighting and power distribution panelboards where indicated on the PLANS.

1.02 RELATED REQUIREMENTS

Work as called for on PLANS, or in this or other Specification Sections.

A. Section 16150 Raceways, Fittings, and Supports

B. Section 16400 Surge Protective Devices

1.03 REFERENCES

Requirements listed in the DRAWINGS and specifications are considered additional to the standard requirements listed herein. The publications listed above form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Grounding system shall be designed, constructed, and tested according to the latest applicable sections of the following standards:

NFPA 70	National Electrical Code
U.L. 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
U.L. 67	Standard for Panelboards
U.L. 489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300 Submittals.

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 – 1.09 (NOT USED)

1.10 WARRANTY

A. Manufacturer shall provide a one year warranty from the time manufacturer's start-up services are completed or 18 months from date of shipment whichever is later. Warranty shall include all parts and labor to troubleshoot and replace failed devices.

1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square D, Cutler Hammer, General Electric

2.02 MATERIALS/CONSTRUCTION

A. Panelboard bus structure and main lugs or main breaker to have current ratings as shown. Such ratings to be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C rise above any ambient of 40°C heat rise tests to be conducted in accordance with U.L. 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All bus to be tinned copper, distributed phase sequence type, and extending the full length of the panel board. Circuit numbering to be such that odd numbered circuits are on the left and even numbered on the right facing the front of the panel. Full size (100% rated) insulated neutral bus shall be included in the panel boards shown with neutral. Spaces for future circuit breakers shall be bussed for the maximum devices that can be fitted.

2.03 FUNCTIONAL REQUIREMENTS

A. CIRCUIT BREAKERS

1. Circuit breakers to be single-pole, two-pole or three-pole as shown. All breakers to be quick-make, quick-break thermal magnetic molded case bolt-on type, with inverse time thermal trip and an instantaneous time magnetic trip. Multi-pole breakers to be common trip with a single trip handle; handle ties are not to be used. Provide overload tripping elements in each pole. "ON" and "OFF" position as well as breaker rating to be clearly indicated. A tripped condition to be indicated by the breaker assuming a neutral position between "ON" and "OFF". Provide high interrupting capacity or fused current limiter type breakers where necessary to withstand the available short circuit or limit it to a value which the downstream breakers can withstand.

2. Circuit breakers to be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers to be flush with each other. Affix large, permanent, individual circuit numbers to each breaker in a uniform position. Provisions for additional breakers to be such that no additional connectors will be required to add breakers. Breakers shall be of the bolt-on type. Independently mount breakers so that a single unit can be removed from the front of the panel without disturbing or removing main bus, other units or other branch circuit connections.

3. Circuit breakers for lighting circuit protection are not to be larger than 20 amperes when serving fluorescent or medium base and mogul base incandescent fixtures.

4. Circuit breaker interrupting ratings and type to be as follows:
   a. 120/208 Volt Panels- 22,000 A.I.C. symmetrical @ 208 Volts.
   b. 480/277 volt panels - 35,000 AIC symmetrical @ 480 Volts

5. Provide GFCI circuit breakers for heat trace circuits. The rating shall be as per NEC.

6. Provide individual breaker handle lock for all circuits that supply exit signs, emergency lights and fire alarm panels.

B. SURGE SUPPRESSOR

1. All 120/208V and 277/480V panelboards shall be provided with Surge Protective Devices in accordance with Section 16400 Surge Protective Devices.

C. INTEGRATED EQUIPMENT RATING

1. Each panel board, as a complete unit, to have a rating equal to or greater than the integrated equipment rating shown on the panelboard schedule on the PLANS. Such rating to be established by test with the circuit breakers mounted on the panelboard. The short circuit tests on the circuit breaker and on the panelboard structure shall be made simultaneously by connecting the fault of each panelboard breaker with the panelboard connected to its rated voltage source. Method of testing to be per proposed U.L. Standards pertaining to listing of molded case circuit breakers for high-interrupting capacity ratings. The source shall be capable of supplying the specified panelboard short-circuit current or greater. Test data showing the completion of such tests upon the entire range of panel boards to be submitted to the ENGINEER if requested by him/her, with or before the submittal of approval drawings. Testing of panelboard circuit breakers for short-circuit rating only with the breaker individually mounted is not acceptable. Testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable.

D. CABINET

1. Panelboard assembly to be enclosed in a NEMA 12 cabinet for panel boards installed inside a climate controlled environment (HVAC controlled environment) or NEMA 4X 316 stainless steel cabinet otherwise. The rigidity and gauge shall be as specified in U.L. 50 for cabinets. Size wiring gutters in accordance with U.L. 67. Fronts to be of code gauge, full-finished steel with rust-inhibiting primer and baked enamel finish. All panelboards shall be door in door construction. The inner door shall be a lockable, hinged door to allow access to the circuit breakers for operation. The outer door shall be a bolted, hinged doorway to allow access to the wire way and terminations. A circuit directory in a metal frame with clear plastic covering shall be provided on the inside of each door. A directory card shall be typed to identify the load served by each circuit. Spare breakers shall be noted in pencil. Panelboard cabinet finish shall be "ANSI #61 Gray."

E. SAFETY BARRIERS

1. The panelboard interior assembly to be dead front with panelboard front removed. Main lugs or main breaker to have a barrier on five sides. The barrier in front of the main lugs to be hinged to a fixed part of the interior. The end of the bus structure opposite the mains are to have a barrier.

F. GROUNDING PROVISIONS

1. Each panelboard to have a grounding bar for connecting equipment grounds.

G. LABEL

1. All panelboards to bear the U.L. label and meet the following Federal Specifications:

   a. FS W-C-375- Circuit Breakers, Molded Case, Branch Circuit and Service

   b. FS W-P-115- Power Distribution Panel

2.04 TOOLS, SPARE PARTS AND ACCESSORIES

A. Provide a minimum of 20% spares on all panelboards and/or as shown on panel schedules on the drawings.

PART III - EXECUTION

3.01 – 3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Install panelboards at the location shown on the drawings.

B. Mount panelboards so that the bottom of the panel board is 3’-0” from the floor. Mount at a lower height if necessary where the top breaker would otherwise be more than 6’-6” above the finished floor elevation.

C. Balance phases as closely as possible and provide typed directory. Use erasable pencil to indicate “Spares” and “Spaces.”

D. Identification: Give panelboard characteristics on 3-ply phenolic “Black - White-Black” laminated nameplate with 1/2” lettering. The nameplate shall have a minimum thickness of 1/8”.

Example: *Lighting Panel “LP”*

120/240 volt, 1-phase

Feeder from MCC-A

E. Use Unistrut or approved equal 316 stainless steel channel supports and fittings for installation, i.e., do not mount/support any panel board directly to building walls.

3.04 REPAIR/RESTORATION

A. As described in Section 16010.

3.05 – 3.06 (NOT USED)

3.07 CLEANING

A. As described in Section 16010.

3.08 (NOT USED)

3.09 STORAGE, HANDLING AND PROTECTION

A. As described in Section 16010.

3.10 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

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PART I - GENERAL

1.01 SCOPE OF WORK

A. Furnish and install lighting fixtures as specified herein and indicated on the drawings.

B. Comply with Section 16010, General Electrical Requirements.

1.02 RELATED SPECIFICATIONS

A. Section 16010 – Electrical General Requirements

B. Section 16010 – Calibration and Testing

C. Section 01340 – Submittals

1.03 REFERENCE STANDARDS

A. The switchboard and all components shall be designed, manufactured, and tested in accordance with the latest applicable following standards:

1. NEMA PB-2

2. UL Standard 891

3. UL Standard 1066

4. UL Standard 489

5. UL Standard 1449 4th edition

1.04 SUBMITTALS

A. Submit a lighting fixture brochure for all fixtures indicating pertinent physical characteristics, finish, pole, base, mounting, hardware, diagram of mounting, and complete photometric data.

PART II – PRODUCTS

2.01 DESCRIPTION

A. General:

1. Furnish fixtures in accordance with lighting fixtures, as called out on the plans.

B. Fixtures shall bear the U.L. label. Such labels shall apply to the fixture as installed.

C. Accessories:

1. Deliver all fixtures complete with suspension accessories, canopies, hickeys, casings, sockets, holders, reflectors, ballasts, diffusers, frames, recessing boxes, etc., all wired and assembled as indicated.

D. Type:

1. Furnish type and size shown on the fixture schedule, listed on the plans. All lighting shall be LED.

2. Fixtures located in Class I Division II areas shall be rated as such.

3. Designated fixtures, as noted on the plans, shall be provided with a battery back-up system. Battery shall provide automatic switchover from normal power to emergency power on detection of power loss. Battery shall energize fixture for a minimum of 90 minutes.

E. Exit Lighting

1. Exit lighting shall be a combination fixture consisting of adjustable LED egress lamps. Face plate lettering shall be illuminated red.

F. Hazardous locations.

1. Fixtures shown in hazardous locations shall be rated as such. Listing shall be investigated, labeled and marked by electrical testing laboratory in accordance with guide information and standards specified for Class I, Div 2, Groups A, B, C, D; UL Standards: UL1204; and Standards: CSA 22.2 No. 30.

2. Material and Finishes Requirements:
   a. LED housing assembly and heat sink must be of extruded aluminum with low copper content for corrosion protection and heat dissipation; free of sharp edges and burrs
   b. LED housing must be finished with epoxy powder coat finish for improved protection against corrosion.
   c. The following lens material options must be available with light fixture: Heat and impact resistant glass; Heat- and UV-stabilized polycarbonate.
   d. Diffused glass lens option must be available for applications requiring low glare
   e. Fixture must utilize silicone gaskets between driver and LED housing, as well as the lens cover and LED board for NEMA 4X and/or IP66 ingress protection against dust and water
   f. Fixtures must not contain mercury or any other hazardous chemicals

G. Protection

1. Protect all fixtures, lenses, and louvers from damage. Leave protective coverings on lenses and louvers until fixtures are installed. Replace all

damaged lenses and louvers immediately prior to final inspection at no cost to the Owner.

2.02 SUBSTITUTIONS

A. Comply with Section 16010, General Electrical Requirements.

PART III - EXECUTION

3.02 INSTALLATION

A. Lighting fixture locations, as shown on the drawings, are approximate. The final location shall be dependent on physical locations encountered during construction. Where lighting fixtures conflict with work by other trades, and must be relocated, the Contractor shall have written approval from the Engineer prior to relocating the fixtures.

B. Maintain perfect horizontal and vertical alignment of fixtures throughout.

C. Do not locate splices or taps within an arm, stem or chain.

D. Locate fixtures to avoid interference with piping, fans, ducts, and other obstructions. Obtain approval of any location differing from the location shown on the plans.

E. Support fixtures adequately by approved means.

F. Replace any damaged fixtures or lens at no cost to the Owner. Leave any protective covering on lens until the fixture is installed.

G. Install all fixtures parallel to walls and structural members.

H. Support all pendant fixtures with swivel type hangers.

I. Install recessed luminaires to permit removal from below to gain access to the outlet or prewired fixture box.

J. Connect recessed luminaire to boxes with flexible conduit and fixture wire.

K. Support fixtures mounted in suspended ceiling with exposed T bar grid system shall be supported from the ceiling T bar grid structure and secured thereto.

L. Support fixtures more than two feet wide by four hangers per luminaire minimum independent of ceiling structure or T bars.

M. Support fixtures that are surface-mounted on T bar grid ceilings by twist clips at each end and in the center. In addition, provide on T bar grid hanger support at each corner if the same is not provided by the ceiling installer.

N. Area Lighting Fixture Metal Poles:

1. Install steel pole on base, in accordance with pole manufacturer's requirements, using anchor bolts of a material and size specifically made for this application. Orient base parallel with curb line.

2. All conduits stubbing up through the base shall be rigid galvanized steel with a plastic insulated bushing on the end.

3. Install a 3/4" x 10'-0" ground rod at the base of the pole to ground the pole.

4. Plumb pole first using leveling nuts then grout in space between base of pole and footing with non-shrink grout.

5. Prime all metal surfaces prior to application of two coats of paint finish. Paint finish shall be suitable for a corrosive environment.

6. Fixture anchor bolts, nuts, and base plate shall be prime coated after installation.

7. Furnish structural concrete base for fixtures. Concrete installation shall comply with 03002.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

Automatic Transfer Switch shall be 3 phase, 480 volt, and capable of transferring the full rating of the service supplied. The transfer switch shall automatically sense the loss of voltage, initiate a generator start and supply power to the entire station.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 (NOT USED)

1.04 DEFINITIONS

A. ATS – Automatic Transfer Switch

1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300.

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 (NOT USED)

1.08 DELIVERY STORAGE AND HANDLING

A. As specified in Section 16010.

1.09 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. ATS manufacturer:

1. ATS shall be as manufactured by Automatic Switch Company- ASCO, Model 300 Series meeting these specifications and all the additional options required herein or equal as manufactured by Russelectric. The ATS meeting these specifications is to be supplied by the generator manufacturer.

2.02 MATERIALS/CONSTRUCTION

A. Transfer switch requirements and unit description:

1. Transfer switch mechanism shall be of the electrically operated, double throw mechanically held type, actuated by a single solenoid operator momentarily energized to assure quiet operation.

2. Transfer switch is to be inherently interlocked, mechanically in either normal or emergency position with no "OFF" position possible. Gravity or spring operated switches will not be acceptable.

3. All main contacts shall be provided with silver alloy material for high conductivity under all conditions of service. Main contacts which require auxiliary arcing contacts will not be acceptable. Arc quenchers shall be of the de-ionizing principle which remove the heat generated by the arc from vicinity of the contacts. The main contacts shall be of the high pressure quick-make and quick-break butt type. The transfer switch shall be suitable for all classes of loads.

4. Power failure relays shall be provided to sense when the voltage of any phase drops below 70% of normal and cause transfer of the load to the emergency source and to sense when all normal source phase voltages are 90% of rated voltage and retransfer to normal source at the point.

5. Failure of any control relay coil shall initiate transfer to the backup source.

6. The operating transfer time of the contacts in either direction (energy or normal power mode) shall not exceed one-sixth (1/6) of a second.

7. The automatic transfer switch shall be furnished complete with the control panel. Both the ATS and the control panel to be mounted in one NEMA 1A enclosure if mounted indoors or NEMA 4X 316SS if mounted outdoors.

8. The control panel shall be supplied with a protective cover and mounted separately from the transfer switch for ease of maintenance. The interconnecting wiring harness shall include a disconnecting wiring harness with a disconnect plug to disconnect all wires including both sources of control power for routine maintenance. Sensing and control logic shall be solid state and mounted on plug in printed circuit boards. Printed circuit boards shall be keyed to prevent incorrect installation. Interfacing relays shall be industrial control grade plug-in type with dust covers.

9. Inspection of all contacts (movable and stationary) shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to stop the contacts at any point throughout the

entire travel to properly inspect and service the contacts when required.

10. The ATS shall conform to the requirement of NEMA standard ICS 2-447 and U.L. 1008 and shall be U.L. listed for:

    a. Use in emergency and standby systems in accordance with articles 517, 700, 701 and 702 of the National Electrical Code (NEC).

    b. Rated in amperes for total system transfer including inductive loads, resistive loads, control loads, and electrical discharge and tungsten-filament loads.

11. The ATS shall be rated to withstand the RMS symmetrical short circuit current of 42,000 amperes (minimum) at 480 volts.

12. Transfer from normal power to backup power shall not take place until backup power is available at the proper operating voltage and frequency levels (i.e., 90% of rated voltage and 60 hertz).

13. ATS contacts rating and number of poles shall be as shown on the PLANS.

B. Transfer switch control panel requirements:

    1. Voltage and frequency session:

        a. Normal power source closed differential voltage session on all phases of normal power source. Pickup voltage to be field adjustable from 90% of 100% nominal, and the dropout to be adjustable from 70% to 90% of the pickup value. Unit to be shipped with the following initial factory settings:

            1) Voltage pickup @ 90%

            2) Voltage dropout @ 85%

    2. Transfer time delays:

        a. Time delay to override momentary normal power source outages to delay transfer switch. Field adjustable from 1 to 3 seconds. Unit to be shipped with the following initial factory settings:

            1) Time delay to initiate loss of normal power alarm set at 3 seconds.

            2) Time delay to retransfer to normal power source: Time delay to be provided for retransfer from backup to normal power source if restored and within present acceptable operating parameters. This time delay is to be automatically bypassed in the event the backup source fails and normal power source is available. Retransfer time delay to be field adjustable from 0 to

30 minutes. Unit to be shipped with the following initial factory setting:

I. Transfer to normal power source time delay set at 15 minutes.

3. Manual transfer switch controls:

   a. Normal power source simulation test switch:

      1) A test push-button switch to momentarily simulate normal power source failure. Switch to be installed and connected on the front of the enclosure.

4. Indicating lights:

   a. System connected to normal power source light:

      1) Green signal light to indicate automatic transfer switch is connected to normal power source. Indicator light is to be mounted on the face of the enclosure and visible without opening any covers or doors.

   b. System connected to backup power source light:

      1) Red signal light to indicate automatic transfer switch is connected to backup power source. Indicator light is to be mounted on the face of the enclosure and visible without opening any covers or doors.

5. Additional spare auxiliary contacts:

   a. Furnish unit with the following additional spare contacts over the number of contacts required to meet the requirements of this specification and the number of contacts required by the automatic transfer switch control schematics:

      1) Two auxiliary normally open dry contacts. Contacts are to change state to closed-position when the automatic transfer switch is connected to backup power source. Contacts to be rated 10 amps at 120VAC. Each contact is to clearly be marked as spare.

      2) Two auxiliary normally open dry contacts. Contacts are to change state to closed-position when the automatic transfer switch is connected to normal power source. Contacts to be rated 10 amps at 120VAC. Each contact is to clearly be marked as spare.

6. Automatic exerciser (option 11CD)

   a. Unit to simulate a normal source failure. The ATS shall transfer the load to the backup source.

1) Unit shall have selectable day and time to operate. The unit shall also be configurable on length of run time.

7. ATS shall have an in-phase monitor to allow transfer and re-transfer of motor loads so that inrush currents do not exceed normal starting currents and cause nuisance breaker trips.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

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PART I - GENERAL

1.01 SUMMARY

Provide electrical grounding system in accordance with the design DRAWINGS, these Specifications and compliance per the NEC. Included within this section are furnishing and installing all wire/cable, ground electrodes, ground connections, ground wells/test wells, ground plates, etc. and ground testing report associated with the electrical grounding system.

1.02 RELATED REQUIREMENTS

A. 01300 Submittals

B. 01730 Operation and Maintenance Manuals

C. 16010 Electrical General Provisions

D. 16150 Raceways, Fittings and Supports

E. 16130 Boxes and Cabinets

F. 16140 Wiring Devices

G. 16200 Wires Conductors Cables – 600V and Below

H. 16205 Wire and Cable Tagging

I. 16950 Calibration and Testing

J. Other related work as may be designated, required, and/or called for per the CONTRACT DRAWINGS, other related TECHNICAL / EQUIPMENT SPECIFICATIONS and/ or as elsewhere defined or designated.

1.03 REFERENCES

Requirements listed in the DRAWINGS and specifications are considered additional to the standard requirements listed herein. The publications listed above form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Grounding system shall be designed, constructed, and tested according to the latest applicable sections of the following standards:

A. ANSI American National Standards Institute

B. ASTM American Society for Testing and Materials

C. IEA International Energy Agency

D. IEEE Institute of Electrical and Electronics Engineers

E. NEC National Electrical Code

F. NEMA National Electrical Manufacturers Association

G. NFPA National Fire Protection Association

H. UL Underwriters Laboratories

I. AEIC Association of Edison Illuminating Companies

J. IAE Instrumentation and Electrical

K. ISA International Society of Automation

L. ISO9001 International Organization for Standardization

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300 and Section 16010. In addition the following specific information here in shall be complied.

B. Submittal Data: Submit the following data for grounding system, accessories and appurtenances:

1. Manufacturer and model number(s) for all system components furnished and installed.

C. Submit data for grounding equipment, grounding systems, materials and terminations.

1.07 (NOT USED)

1.08 DELIVERY STORAGE AND HANDLING

A. Grounding equipment, materials, supplies, etc. shall be stored off the ground and kept dry at all times, up through the time of installation. Handle with care to prevent damage, loss or compromise of its packing material.

1.09 – 1.10 (NOT USED)

1.11 OPERATION AND MAINTENANCE MANUALS

A. Furnish complete documentation and quantity per Section 01730. As a minimum, O & M Manuals shall provide the following:

1. All grounding testing data and report(s), per Section 16950.

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. Ground plate thickness shall be 0.032" with a minimum surface area of 24" x 24" (ThermOweld Part# 38-6341-"X" or approved equal). The ground plate should have manufacturer terminated welded pigtails (sized as indicated on the Plans) or as designated per the design DRAWINGS.

B. Contractor shall use ground enhancement material (GEM) around ground plates (ThermOweld Part# 38-6502-"XX"). GEM shall be mixed per manufacturer's instructions to encapsulate ground plates.

C. Ground connection and wire/cable shall be as follows:

1. Below grade: Cadweld, Burndy Thermoweld, or approved equal thermite reaction welding system ground connection.

2. Above grade: Burndy Type GAR, GB, GBM or GG connector as required or approved equal. Where applicable and/or as designated, install thermite weld ("Thermoweld, Cadweld, etc.") ground cable connection to all designated equipment and/or metal structural grounding above grade.

3. Ground wire shall be green color insulation, stranded, copper conductor XHHW-2 rated for raceways/conduits and bare, stranded, annealed copper wire/conductor for underground ground grid, ground loop/s, etc. Ground wire shall be sized as designated on the designed DRAWINGS compliance per N.E.C., not less than #6 AWG service ground and not less than #2/0 AWG bare copper ground for underground ground grid, ground loop/s, etc.

4. Ground well/test well(s) shall be precast box with accessible cast iron lid. Lid shall read "Ground" on top. Brooks precast box, model # 3-RT, not less than 10" DIA x 12" deep or approved equal—see applicable ground well detail per the Contract Drawings. Ground well/s located in driveway shall have AASHO H-20 traffic load rating.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 – 3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Ground Grid

1. Install the number of ground electrodes, ground wells/test wells as shown on the DRAWINGS.

2. Do not cover/backfill below grade/concealed connections until each connection has been inspected by the ENGINEER / Austin Water. Where applicable and/or as designated, ditto this process for above grade ground connections to designated equipment and to metal structural ground connections.

3. Provide minimum of one ground test well accessible for ground grid testing and connection inspection. Utilize a ground test well with removable cover for accessibility from finished grade—comply as specified here-in.

B. General Equipment Grounding

1. Ground all electrical equipment, lights, receptacles, etc., with a separate equipment ground wire/conductor installed in the conduit with the power conductors. Provide/install ground wire/conductor in all conduit/raceway compliant per N.E.C.

2. Install grounding system electrically and mechanically continuous throughout. Do not bond to the system neutral except at the service transformer or service main disconnect switch or breaker.

3. Install a bonding jumper from the grounding lug on each conduit to the ground bar or bus.

C. Where the equipment has no facility to attach an equipment ground wire, use a Burndy Quicklug or equal. Clean the metal surface under the lug to bright metal so that good contact can be made. Size general equipment ground wire not less than #10 AWG, stranded copper; major equipment–panel board, motors, compressors, etc. ground wire size shall comply per N.E.C. for equipment grounding and/or per the design DRAWINGS.

D. Provide a PVC sleeve where bare ground wire passes through concrete slab at or above ground level, where applicable.

E. Connect ground wires entering outlet boxes in such a manner that removal of the receptacle will not interrupt the continuity of the grounding circuit. A grounding screw attached to the box, and used for no other purpose, may be used to accomplish this.

F. Install a separate ground plate for lighting poles. Ground plate to be brought up through light pole foundation into base of light pole accessible via pole base hand hole. Make lighting pole ground connection to the ground plate inside the pole base (See DRAWINGS detail).

G. Ground system "resistance" shall measure not more than 2.0 Ohms for power / instrumentation / communications / computer / network systems.

3.04 – 3.07 (NOT USED)

3.08 TESTING AND INSPECTION

A. Ground system shall be calibrated and tested. Provide ground system test data and report/s –compliance per Section 16950 "Calibration and Testing".

B. Do not cover/backfill below grade/concealed connections until each connection has been inspected by the ENGINEER / Austin Water. Where applicable and/or as designated, ditto this process for above grade ground connections to designated equipment and to metal structural ground connections.

3.09 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

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

END OF SECTION

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PART I - GENERAL

1.01 SCOPE OF WORK

A. Furnish labor, design, materials, equipment and incidentals necessary to install a complete lightning protection system in accordance with UL 96A, NFPA 780, and this specification for protection of the pump station and ground storage tank. Lightning protection system shall be tied to the pump station grounding system.

1.02 QUALITY ASSURANCE

A. The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design. Listing of the manufacturer in the lightning protection section of the current edition of Underwriters' Laboratories, Inc., Electrical Construction Materials List will be accepted as compliance with this requirement.

B. All materials shall be copper and bronze and of the size, weight and construction to suit the application where used in accordance with UL, NFPA, NEC code requirements for this type structure and as per manufacturer's recommendations. Class I sized components may be utilized on roof levels 75 feet and below in height. Class II sized components are required for roof levels over 75 feet in height.

1.03 REFERENCE STANDARDS

A. Refer to Section 16010, GENERAL ELECTRICAL REQUIREMENTS, for all standards which apply to this section.

1. NFPA 780:

    a. Standard for the Installation of Lightning Protection Systems.

2. UL 96A:

    a. Standard for Installation Requirements for Lightning Protection Systems.

3. LPI 175:

    a. Lightning Protection Institute Standard of Practice

1.04 SUBMITTALS

A. Submittals shall be accordance with Section 01300, CONTRACTOR’S SUMBITTALS, and shall include:

1. Specifications

2. Catalog outs

3. Shop drawings showing type, size and location of all equipment, grounds, cable routings, etc.

4. Approvals

5. UL Master Label

PART II – PRODUCTS

2.01 MATERIALS

A. Materials used in connection with the installation of the lightning protection systems shall be approved for lightning protection systems by the Underwriters' Laboratories, Inc. No combination of materials shall be used that form an electrolytic couple of such a nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. When unusual conditions exist which would cause deterioration or corrosion of conductors, conductors with suitable protective coatings or oversize conductors shall be used. If a mechanical hazard is involved, the conductor size shall be increased to compensate therefore, or suitable protection shall be provided. The conductors may be protected by covering them with molding or tubing, preferably made of wood or nonmagnetic material. If metal tubing is used, the conductor shall be electrically connected to it at its upper and lower ends.

B. All equipment used shall be new and of a design and construction to suit the application in accordance with UL 96A requirements and shall be so marked.

2.02 MATERIALS

A. CONDUCTORS:

1. Copper conductors manufactured of copper grade ordinarily required for commercial electrical work are generally designated as being 98 percent conductive when annealed. Down conductors of copper cable for installations other than towers shall weigh not less than 187.5 pounds per thousand feet and the size of any wire of this cable shall not be less than No. 17 AWG (0.045 inch). Down conductors shall be tinned. The thickness of any copper ribbon or strip shall be not less than No. 16 AWG (0.051 inch).

B. AIR TEMINALS

1. Air terminals shall be tapered to a blunt point. The rod shall be of solid copper, 1/2 inch in diameter. Air terminals and support shall be designed over 24 inches to handle a 75 pound per square foot wind load. All air terminals shall be supported by a suitable brace, with guide(s) not less than one-half the

height of the air terminal. Air terminals shall be located in accordance with the requirements of NFPA 780 and UL 96A. Air terminals shall extend at least ten inches above the object or area they are intended to protect. Air terminals shall be placed around the perimeter of flat or gently sloping roofs at intervals not exceeding 20 feet.

C. FASTENERS:

1. Fasteners shall be of the same material as the conductor base material or bracket being fastened, or other equally corrosion resistant material. Galvanized or plated materials shall not be used.

D. FITTINGS

1. Fittings/bonding devices, cable splicers, and miscellaneous connectors shall be suitable for use with the installed conductor and shall be copper, bronze or aluminum with bolt pressure connections to the cable. Cast or stamped crimp type fittings shall not be used.

PART III - EXECUTION

3.01 FACTORY TESTING

A. The Contract Drawings (shop drawings) shall indicate the extent and general arrangement of the lightning protection system. If any departures from the Contract Drawings (shop drawings) are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer. Lightning protection systems for all applications shall conform to National Fire Protection Association Code No. 780 and the NEC, whichever is more stringent.

B. Installation shall be performed by a certified master installer. Installer shall provide an Underwriters' Laboratories Master Label for the facilities.

C. Air terminals shall be provided on the highest projections and at intervals not exceeding 20 feet along the perimeter top surface. Air terminals shall extend at least 10 inches above the object or area that they are intended to protect. Air terminals shall be connected to the lightning protection system when so specifically authorized by the Engineer.

D. Roof and down conductors shall be stranded and shall meet the requirements given in NFPA 780. Roof and down conductors shall maintain a horizontal or downward course. No bend in a roof or down conductor shall form an included angle of less than 90 degrees, nor shall it have a bend radius of less than eight inches. Conductors shall be routed external to buildings and six feet or more from power or signal conductors. Down conductors shall be routed outside of any structure and shall not penetrate or invade that structure. All down conductors except one may be provided with a screw type connector as described in UL 96 where lightning protection system testing may be required.

Down connectors shall be supported from and secured to the building exterior using one hole straps of copper or bronze at maximum intervals of three feet.

E. Guards shall be provided for down conductors located in or next to driveways, walkways or other areas where they may be displaced or damaged. Guards shall extend at least six feet above and one foot below grade level. Guards shall be metal pipe. Metal guards shall be bonded to the down conductor at both ends. Bonding jumpers shall be of the same size as the down conductor. Crimp type fittings shall not be used.

F. Metallic bodies, on or below roof level, that are subject to induced charges from lightning include exhaust fans, radio towers, HVAC units, ladders, railings, antennas, roof drains, plumbing, vents, metal coping, metal flashing, gutters, downspouts, small metal wall vents, door and window frames, metal balcony railings, and in general any isolated metallic body within six feet of an exposed lightning protection system element. When these metallic bodies have a metal thickness of 3/16 inch or greater, they shall be bonded to the nearest main lightning protection system conductor with UL approved fittings and conductors meeting the requirements of NFPA 780. These bonding fittings shall provide surfaces of not less than three square inches. Provisions shall be made to prevent corrosive effects introduced by galvanic action of dissimilar metals at bonding points. If the metal parts of these units are less than 3/16 inch thick, additional approved air terminals, conductors and fittings, providing a two way path to ground from the air terminals shall be installed.

G. If metallic, the mast of roof mounted antennas and obstruction lighting shall be bonded to the nearest roof or down conductor using UL approved fittings and conductors. The bonding jumpers shall be of the same size and material as the roof or down conductor to which they are connected. Provide two paths for ground.

H. The lightning protection system for the ground storage tank shall consist of installing air terminals at 20 foot intervals along the perimeter top surface of the tank and anywhere else on the top of the tank that is required by UL, NFPA and LPI. Air terminals shall extend at least 10 inches above the tank. Air terminals shall be connected together with a cable ring conductor. "Down" conductors shall extend from the cable ring conductor down the side of the tank to the earth connecting to the ground rods or ground electrode plates.

3.02 FIELD QUALITY CONTROL

A. The lightning protection system will be inspected by the Engineer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Engineer.

B. The Contractor shall establish and maintain quality control for the "Lightning Protection System" installation to assure compliance with contract requirements and shall maintain records of his quality control for all construction operations. A copy of these records and Contractor tests, as well as records of corrective action taken, shall be furnished to the Engineer. Contractor shall obtain an

Underwriters' Laboratories Master Label for the facility.

C. Testing of Continuity of all Conductors:

1. A copy of these records and tests, as well as the records of corrective action taken, shall be furnished to the Engineer.

END OF SECTION

PART I - GENERAL

1.01 SCOPE OF WORK

A. Provide all equipment and labor required for calibration, setting, and testing as described herein or otherwise required. All tests are to be witnessed by the Owner and Engineer. Give written notification of the tests at least seven days prior. Repair or replace all defective material, equipment or workmanship disclosed as a result of these tests at no additional cost to the Owner.

1.02 RECORDS

A. Provide the Owner copies of reports of all the tests listed herein. Reports shall include the piece of equipment or wiring tested, the date tested, weather conditions, and test value results. Include test reports in Operations and Maintenance Manuals. Refer to Section 16010 for O&M Manual requirements.

PART II – PRODUCTS

2.01 MATERIALS

A. Use meters, megger and other test devices specifically approved for the test.

B. Test devices to be provided with calibration certificate.

PART III - EXECUTION

3.01 MEGGER TESTS

A. Use a minimum of 500 volt megohmmeter.

B. Take each reading for at least one minute.

C. Include the following test:

1. 115 and 230 volt motors…….5.0 Megohms

2. 460 volt motors……7.0 Megohms

3. 600 volt wiring up to 1000 ft…….25.0 Megohms

D. Test all wiring including main service feeders, motor feeders and branch circuit wiring.

3.02 GROUND TESTING

A. A certified test report of all standard production tests shall be available to the

Engineer upon request.

B. Measure the resistance of each ground rod. Submit in writing to the Owner a record indicating the rod location, the resistance measured and the soil condition at the time.

C. Take ground resistance measurements on the building water service where it is used as a ground also.

D. Install additional grounding if the resistance to ground measures more than 25 OHM's at any location.

3.03 MOTOR TESTING

A. Megger test motors for insulation and stator winding resistance.

B. Dry out any wet insulation by use of space heaters or other approved methods.

C. Check coupling alignment, shaft end play, lubrication and other mechanical checks as required. Follow manufacturer's instructions.

D. Check for proper rotation.

E. Combined or coupled motor and pump vibration testing under actual pumping conditions. At both full and reduced speeds.

3.04 RECEPTACLES

A. Test all receptacles for proper connections and grounding. Use an approved plug-in tester.

3.05 CONTROL CIRCUITS

A. Check all circuits for continuity, proper connection and proper operations.

B. Set all-time delay relays and timers for the desired operation. Record the settings, indicating the relay or timer, its location, and the setting used. Verify all settings with a stopwatch.

3.06 LIGHTING

A. Turn on all lights after lamping them with new lamps.

B. Turn on all lights at each panelboard with lights on and submit typewritten results to the Owner. Results include panelboard number and location, branch circuit number and load served, and amperage reading.

C. Allow outdoor lights to remain on for 72 hours to check ballasts as well as lamps. Replace any defective material.

3.07 MOTOR CONTROL CENTERS

A. Set all motor circuit protectors, all feeder circuit breakers and all overload relays.

B. Record the following information and submit the same to the Engineer for checking:

1. Motor control center number.
2. Motor control center location.
3. Feeder breaker or starter.
4. Load served and location.
5. Full load amps.
6. Locked rotor amps.
7. Overload heater unit used.
8. Overload relay setting used.
9. MCP setting used.

C. Take and record amperage readings on all feeders and motors to ensure proper phase balance.

3.08 MAIN CIRCUIT BREAKER

A. Set main circuit breaker to coordinate with the upstream Electric Utility's overcurrent protective device while providing NEC required protection of main service feeders.

B. Record the following:

1. Breaker rating (frame size and trip size).
2. Magnetic trip setting.

END OF SECTION

PART I - GENERAL

1.01 SCOPE

A. Provide all labor, materials, and equipment to furnish, configure, program, install, calibrate, test, adjust, and place into operation the facility's additions and modifications to the existing monitoring and control system as specified herein and described in the Specifications and as shown on the Drawings. The Drawings and Specifications show and specify those features required to illustrate and describe functional requirements of the additions and modifications of the monitoring and control system.

B. A single Instrument and Control System Contractor (ICS) shall furnish all services and equipment defined herein and in other Specification sections as listed below under Related Work. The Instrument and Control System Contractor is referred to herein and after (in Division 17 of the Specifications) as the ICS, ICS supplier/firm, or Contractor. The ICS shall have the qualifications as described in the "Quality Assurance" subsection.

C. The ICS shall also:

1. Supply all instrumentation (wired and non-wired), analyzers, that are not specifically listed as vendor supply.

2. Terminate and tag all field wiring associated with the Process instrumentation and control System shown on the DRAWINGS and specified herein and in other Specification sections listed below under Related Work.

3. Tag Instrumentation and control wiring/cable per the requirements and methodology/scheme outlined in specification Section 16205 "Wiring (600 Volts and Below)", "Wire Tagging Methodology".

4. Provide, factory assembly, configuration, programming, testing (factory and field) and commissioning of the Balance of Plant PLC based control panel hardware and software.

5. Update existing Plant HMI screens, trends, alarms, event logs and historian to incorporate all new processes, including vendor provided processes under this contract and in accordance with AW programming standards.

6. Calibrate, set, and test the Supervisory Control and Data Acquisition (SCADA) system, equipment, components, cables, hardware, and software.

7. For all Process instrumentation and control System (PICS) equipment and ancillaries, the ICS shall provide:

   a. Required hardware submittals for all components of the PICS in accordance with Division 1 requirements and these specifications.

b. Equipment and ancillaries.

c. Instructions, details, and recommendations to, and coordination with, all other installation entities for Certificate of Proper Installation. This includes configuration of all instrumentation.

d. Certification of readiness for operation.

e. Start up and Commissioning services

f. Design, develop, and electronically draft loop drawings, control panel designs and site layouts

g. Fabricate panels

h. Perform factory tests on panels

i. Perform bench calibration and verify calibration after installation

j. Oversee and certify installation (inclusive of Vendor packages)

k. Oversee, document, and certify loop testing

l. Oversee, document, and certify system commissioning

m. Conduct the performance test

n. Prepare Owner's manuals

o. Conduct training classes

p. Prepare record drawings

q. Furnish, install, configure and program the switches, and plant PLC's to communicate and operate as outlined in the contract documents and per the Owner's standards.

r. Spare parts list including cost per item provided

s. Field testing/calibration of sensors and instruments, using equipment appropriate to the device, including, but not limiting to:

    1) Test pressure pump for field calibration/testing of pressure transmitters.

    2) Signal generator/multi-function meter for field calibration/testing of resistance temperature detector (RTD) monitoring devices

    3) Temperature/heat generator for field calibration/testing of temperature transmitters.

8. Provide special additional services during installation, including:

   a. Verify that the following are furnished and installed:

      1) Correct type, size, and number of signal wires with their raceways.

      2) Correct electrical power circuits and raceways.

      3) Correct size, type, and number of PICS related pipes, valves, fittings, and tubes.

      4) Correct size, type, materials, and connections of process mechanical piping for in-line primary elements

   b. For equipment not provided by the ICS, but directly connected to the PICS:

      1) Obtain manufacturer's information regarding installation, interface, function, and adjustment for equipment from the Contractor.

      2) Coordinate with Contractor to allow required interface and operation with the PICS.

      3) Verify that installation, interfacing signal terminations, calibration, and adjustments have been completed in accordance with the manufacturer's recommendations.

      4) Test to demonstrate the required interface and its integrated operation with the PICS.

      5) Equipment in this category includes the following:

         a) OWNER's Top-End Computer System (i.e. existing iFix servers and Proficy Historia servers and supporting network)

         b) Project Process/Mechanical Equipment

         c) Project Switchboards/Motor control centers/Power monitoring units

D. Effort is required of the ICS to establish functional and complete communication network links between the proposed equipment of this project and the Owner's existing SCADA equipment in order to achieve proper and complete system operation. This effort shall include, but not be limited to:

   1. Terminating new cabling in the OWNER's existing equipment.

   2. Coordination with all responsible parties, i.e., OWNER/ENGINEER,

manufacturers, etc., to facilitate proper communication equipment selection, cable termination connector quantities/types, patch panel locations in control panels to address minimum cable bending radius, etc., as required.

3. System startup testing, diagnosing, and resolving communication system issues, etc.

E. Extensive field verification is required for all modifications to existing control panels. The ICS shall field verify spatial dimensions inside the existing control panels for proposed equipment, wiring terminations, loop power supply sizes, loads on existing instrument loops, points of connections to existing equipment, etc. as required to support the proposed modification effort associated with this project. The ICS shall field locate proposed equipment to be installed inside the existing control panel as also shown on the DRAWINGS. The proposed location shall be coordinated with the arrangement of the existing control panel internally and externally mounted components.

F. The OWNER's existing SCADA system is vital to the operation of the OWNER's facility. Therefore, required interruptions to the OWNER's existing SCADA shall be minimized and coordinated with the OWNER. Should an outage to a facility be required, the Contractor shall request such an outage in writing no less than two (2) weeks in advance.

Contractor's written request shall identify the desired date, time, duration, and purpose of the requested day unless he/she obtains a written approval from the owner authorizing the outage. The OWNER reserves the right to modify or reject any request for such an outage. Modification or rejection of the contractor's request by the OWNER shall **NOT** be considered reason for delays in the construction schedule. Unless otherwise noted, the duration of the outage shall be limited to four (4) hours or less. The OWNER reserves the right to limit the duration of the outage to less than 4 hours. Modification of the outage duration by the OWNER shall **NOT** be considered reason for delays in the construction schedule.

G. It is the ICS responsibility to identify any deficiencies in the existing SCADA system equipment and any other equipment **PRIOR** to starting construction or demolition activities. Should the existing equipment, its associated interconnect wiring, power supplies, fuses, etc., as applicable, be damaged or become otherwise unusable during the construction course of this project, the ICS shall determine the problem, correct it, and furnish and install all necessary wiring/hardware/etc., to match existing and make all final connections such that all affected equipment operates as previously operated to the OWNER's satisfaction at No Additional Cost to the OWNER.

H. The ICS shall facilitate the construction sequencing requirements of this project. If applicable, this shall include any and all temporary installation of proposed equipment as shown on the DRAWINGS and all associated wire termination, tagging, testing, etc. required to make the equipment operational and fully functional. Effort shall also be included to relocate the temporarily installed equipment to their permanent location as well as all associated re-termination, re-tagging, re-testing, etc., to make this

equipment operational and fully functional. This shall include coordination with the existing field conditions, proposed motor starters and existing control system to maintain continuous facility operation. Refer to the DRAWINGS for additional requirements.

I. The ICS will be responsible for coordination of any inter-PLC IO messaging requirements with the Vendors (i.e., Vendor-to-Vendor or Vendor-to-Plant) as necessary to accommodate the control programming and system integration requirements detailed in Section 17900 – Plant Control Philosophy. The ICS will also be responsible for display of the Vendor developed screens at the Plant HMI, ensuring a common look, function, accessibility and means of navigation. The Vendor screens will be incompatible with the Plant SCADA HMI and the ICS shall be required to re-create all Vendor screens in accordance with the existing AW graphic standards.

J. Experience Requirement: The Instrument and Control System Contractor (ICS), under contract with the CONTRACTOR, shall be responsible for procuring, assembling, configuring, programming, factory testing and field commissioning the plant PLC-based control system as described in the contract documents. The CONTRACTOR shall be responsible for system installation and operation in accordance with the contract documents and shall provide the services of qualified System Integrator field engineers and installers capable of directing and executing installation, pre-commissioning and startup activities as it relates to the vendor packages, plant PLC control system equipment and other CONTRACTOR free-issued components. The CONTRACTOR, through the use of System Integrator personnel shall also coordinate the work of vendor package integration with the balance of plant control system. In support of this work responsibility, the System Integrator shall be required to demonstrate experience at, and capability of, providing similarly sized and complex control systems for Municipal Water or Wastewater Treatment Plants. Experience and capability requirements shall include as a minimum:
   1. Experience in furnishing and installing Control Systems based on the Schneider Electric Modicon processors (PLCs), Viejo/Magelis software, and iFix for similarly sized control systems for Municipal Water or Wastewater Treatment Plants.
   2. A permanently employed in-house staff dedicated to the design, engineering, project management, training, programming, and configuration of PLC equipment, fiber optic communications and managed control system networks. The System Integrator shall have the staff size and experience to provide all required services in a timely and expert manner, as dictated by the Project Construction Schedule.
   3. Permanent employment of programmers who have a minimum of five years' experience at programming Schneider Modicon processors (PLCs), the Vijeo Designer control system software package, GE Proficy iFIX software package, latest version of each software package available.
   4. Experience in furnishing, installing and testing Ethernet networks for similarly sized control systems.
   5. Successful completion of at least four projects within the last six years

of similar size and type.

6. The CONTRACTOR shall submit a resume summary of the Project Manager, Lead Instrumentation / Controls Engineer, and all control system programmers anticipated to take part in the project. The resume shall list the education level, training and experience qualifications of the Project Manager (i.e. the person who will serve as the primary decision maker and interface to the CONTRACTOR), the Lead I&C Engineer (i.e. the person who will serve as the lead technical decision maker), configuration, installation and security) and the control system programmers along with (3) named references (with contact numbers) for projects completed in the last 6 years. In addition, the following qualifications must be met or exceeded:

    a. The Project Manager shall provide evidence of management of similar sized projects and/or projects of similar complexity. A minimum of three projects over the last 6 years must be identified.

    b. The Lead Instrumentation / Controls Engineer shall be an engineer with a minimum 4 year degree (Electrical, Mechanical or Chemical Engineering) from a college accredited by the American Consulting Engineering Council as an Engineering College.

7. Where the specification calls for Manufacturers' representative's services, the CONTRACTOR'S employees will not be accepted as qualified to do the work or be compensated for the services. The CONTRACTOR will only be paid for service of representatives that are in direct employment of the equipment manufacturer

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Division-16: ELECTRICAL SPECIFICATIONS

D. Division-17: INSTRUMENTATION AND CONTROL SPECIFICATIONS

E. All other divisions of the Specifications related to the installation of the process mechanical equipment, etc. that are related to the operation of the instrumentation and control system.

F. Related work as called for on the DRAWINGS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS (Vendor and Non-Vendor)

A. General:

1. Do not design, manufacture, or ship any PICS equipment until all related submittals have been reviewed and approved by the ENGINEER. Submit shop drawings and product data in complete functional packages, i.e., submit all shop drawings and product data for a given loop or subsystem together as a functional package. Piecemeal submittals not organized by systems or incomplete submittals for a given loop or subsystem will not be accepted.

2. All system layout drawings, cross sectional view drawings, instrument loop drawings, wiring diagram drawings, Connection detail drawings, physical layout, and detail drawings, etc. shall be developed and red-lined (to reflect the "as-built" conditions) electronically using "AUTOCAD software".

B. Administrative Submittals:

1. Schedule of Values

   a. Purpose: Project Schedule of Values to provide a basis for Partial Payment for Work completed.

   b. Content: Summary of major milestones and associated Partial Payments for Work provided under PICS Subsystems.

   c. Show a specific line item and value for all workstations, computers, laptops, if applicable.

   d. Show a specific line item and value for all spare parts and tools, if applicable.

   e. Show specific line items and values for all training to be provided as follows, if applicable:

      1) SCADA Hardware Training

      2) SCADA Software Training

3) Top-End Software Training

4) Ethernet Hardware/Software Training

5) Control Panel(s) Training

6) Instrumentation Training

7) Miscellaneous Training

2. PICS Progress schedule

a. Purpose: Supplement the overall Project Progress Schedule to:

1) Coordinate activities between the Contractor and the ICS

2) Coordinate interactions with the OWNER/ENGINEER for coordination meetings, submittal reviews, etc.

3) Clarify required work sequences and major milestone prerequisites.

b. Provide multiple submittals of the project schedule throughout the duration of the Project as required.

3. OWNER Training Plan: Submit description/schedule of OWNER Training to be provided.

4. Spare parts list shall include the following:

a. Product Description

b. Manufacturer

c. Part Number

d. Serial Number, if applicable

e. Quantity

f. Unit Pricing

5. Statements of Qualification: Submit for PICS firm, site representative, start-up and testing team members.

C. Submit shop drawings as specified below:

1. Detailed product data, catalog cut sheets, cabinet exterior and interior front elevations, bill of materials, and spare parts list including pricing

2. Point-to-Point Wiring Diagrams: Prepare Point-to-Point Instrument Loop Wiring Diagrams, ladder diagrams (control schematics), cabinet wiring, and other field wiring diagrams in accordance to the format shown on the DRAWINGS. Drawings shall be neat; and legible, and on 11 inch x 17 inch sized sheets and electronically formatted pages. Drawings to include all relevant information for equipment connected to the PICS, regardless of whether the equipment is provided by the ICS or not, i.e., include motor control centers, OWNER pre-purchased equipment, etc. Contractor shall also submit for approval a complete schedule of all wire tag numbers sorted by area and equipment/instrument/field device.

3. Although typical control schematics/instrument loops are presented on the DRAWINGS for some equipment, the Contractor shall generate specific equipment control schematic drawings/instrument loops (i.e., individual control schematic/instrument loop drawings dedicated for each specific equipment) based upon the typical control schematic/instrument loop drawings, the device identification/tag replacement schedules shown on the DRAWINGS, and the additional requirements described herein. The Contractor generated specific equipment control schematics/instrument loops shall follow the same overall presentation format as the typical equipment control schematics/instrument loops presented on the DRAWINGS. The specific equipment control schematics/instrument loop drawings complete with all specific equipment/device tags (as a minimum, also refer to the additional requirements described herein) shall be generated by the Contractor and included with the project submittals (i.e., prior to equipment purchase) and the "As-Built" drawings. Any Contractor generated control schematic/instrument loop shown as applicable for multiple equipment shall not be accepted.

4. Wire Tags:

    a. Samples Submittal: Contractor shall submit for approval wire tag samples for all types of interconnects and field wiring from the proposed/existing cabinets/panels with associated point-to-point wiring diagrams in a separate submittal prior to submitting the complete wire tag schedule for review.

    b. Wire Tag Table and Wiring Diagrams Submittal: After the sample wire tags are approved, the Contractor shall submit a wire tag table showing all provided wire tags, along with the associated point-to-point wiring diagrams. Refer to Specification hereinafter for additional wire tag table requirements. Refer to Specification 16205 "Wiring (600 Volts and Below)", "Wire Tagging Methodology".

    c. Wire Tag Numbers Complete Schedule Submittal: Contractor shall also submit for approval a complete schedule of all wire tag numbers sorted by area and equipment/ instrument/ field device.

d. Wire Codes / Wire Numbers Cross Reference Table: It is anticipated that all wire numbers cannot be accommodated on the format shown on the DRAWINGS for loop diagrams, ladder diagrams, control schematics, etc. To facilitate the depiction of wire numbers on these types of drawings, the Contractor shall at minimum generate uniquely identified alpha-numeric wire codes and do the following:

1) Include them on the loop diagrams, ladder diagrams, control schematics, etc.

2) List them on cross-reference tables of wire numbers shown on additional drawings, and

3) Group wire codes and drawings by specific process equipment, such as Transfer Pump No. 1, Transfer Pump No. 2, etc. The OWNER shall provide additional requirements for the table headings, table organization, wire code generation, and formatting during the Pre-Submittal Conference specified hereinafter and the Contractor shall incorporate these requirements at no additional cost to the Owner.

D. Testing Related Submittals:

1. Submit factory and field calibration reports as required per the individual instrument specifications.

2. Submit the following for each of type of test (ORT and PAT) required under Division 17 of the Specifications:

a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.

b. Final Test Procedures: Proposed test procedures, forms, and checklists.

c. Test Documentation: Copy of signed off test procedures when tests are completed.

E. Training Related Submittals:

1. Submit the following for each type of training required under Division 17 of the Specifications:

a. Training plan, course to PICS, subjects to be addressed in the training

b. Schedule

c. Training agenda for each course

d. Instructor qualifications

e. Listing of available training courses and outline of course to PICS and agendas

F. Submit Operation and Maintenance manuals in accordance with Section 01730 of the Specifications and as specified below:

1. Include approved shop drawing data in the Operation and Maintenance manuals with the following modifications to the shop drawing exhibits:

a. Reflect "As-Built" conditions.

b. Prints of exhibits, wiring diagrams, etc. shall be half size (11-inch by 17-inch).

c. Submittals shall include hard copies (of the quantity and format required by the Contract Documents) and electronic version in "AUTOCAD"; This applies to all drawings requested in this Section of the Specifications and any other manufacturer's product standard drawings required for submittal.

2. Procedures for operating and shut-down

3. Included approved Testing Related Submittals with final "As-Built" conditions.

4. Safety instructions.

5. Calibration instructions and factory test results of each instrument.

6. Maintenance and repair instructions.

7. Recommended spare parts list with individual pricing.

8. Name, address and phone number of instrumentation control system supplier's local representative.

9. Additionally, comply with the requirements of the Contract Documents.

G. Pre-submittal conference

1. General:

a. Review the manner in which the contract requirements will be met prior to preparation of submittals. The Contractor, Engineer, OWNER, and ICS shall attend. Schedule, conduct, and arrange the conference within 14 calendar days after receipt of written notice to proceed work is given by the OWNER. The OWNER may elect to cancel the pre-submittal conference if so desired and proceed directly to the submittal process.

b. The ICS shall present the following at the conference:

1) List of equipment and materials required and the brand that shall be used for each item

2) Sample submittals from similar projects including the types of drawings/data/lists specified herein

1.04 SPECIAL CONDITIONS

A. All components used in the instrument and control systems shall be new (**NOT** used) and the current model produced by the manufacturer.

B. All equipment of a common type shall be the product of a single manufacturer.

PART II - QUALITY ASSURANCE

2.01 ACCEPTABLE PROCESS INSTRUMENTATION AND CONTROL SYSTEM (PICS)

A. Provide a complete, workable, and installed-in-place Process Instrument and Control System, hereinafter referred to as the PICS, as specified herein. The PICS shall be designed, installed, and started up by the single ICS firm.

B. Acceptable ICS firm shall have the following minimum qualifications:

1. ICS Firm: Minimum of 5 years' experience in providing, integrating, installing, testing, and start-up similar systems as those required for this project

2. ICS Firm Site Representative: Minimum of 8 years' experience installing similar systems as those required for this project

3. ICS Firm Start-up and Testing Team Members: Minimum of 3 years' experience in testing systems similar to those required for this project.

4. ICS Firm shall have a minimum building size of 5,000 sq ft.

C. PICS meetings to be scheduled in accordance with the Contract Documents.

2.02 SYSTEM COORDINATION AND QUALITY

A. Coordinate installation of instrumentation with mechanical and electrical systems.

B. Coordinate subsystems to provide a complete operational and functional instrumentation system to the satisfaction of the Owner and Engineer.

C. Equipment, instruments, components, and materials for PICS components shall be new (not used) and of the current model.

D. Instrument and Control Components Furnished by Others: Certain items of instrumentation and controls shall be furnished by various equipment manufacturers. Coordinate the purchase orders of the items such that the resulting system will function properly.

2.03 DESIGN CRITERIA

A. Design, construct, and install all PICS components in compliance with the applicable provisions of the following standards, codes, and regulations:

1. American National Standards Institute (ANSI) Standards.
2. American Institute of Steel Construction (AISC) Standards.
3. American Society for Testing and Materials (ASTM) Standards.
4. American Waterworks Association (AWWA) Standards.
5. Joint Industrial Council (JIC) Standards.
6. National Electric Code (NEC)
7. National Electrical Manufacturer's Association (NEMA) Standards.
8. Local and State Building Codes.
9. Occupational Safety and Health Administration (OSHA) Regulations.
10. Scientific Apparatus Manufacturer's Association (SAMA) Standards.
11. International Society of Automation (ISA) Standards.
12. National Fire Protection Association (NFPA)
13. Institute of Electrical and Electronics Engineers (IEEE).
14. Underwriters Laboratories (UL) 508A

2.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Enclose cabinets and subassemblies in heavy polyethylene envelopes to protect them from dust and moisture. Place corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

B. Storage: All materials and equipment shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment. The Instrument Control Panels and the field control and instrument/monitoring panels shall not be moved from climate-controlled storage room to the project site until the construction of each electrical/control room is completed, and the air-conditioning and heating system of the facility is in an operating condition satisfactory to the OWNER and ENGINEER.

2.05 CALIBRATION INSTRUMENTS

A. Each instrument used for calibrating PICS equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous twelve (12) months to a standard endorsed by the National Institute of Standards and Technology (NIST). At OWNER's request, ICS shall submit calibration certification report.

2.06 START DATE OF THE PROCESS CONTROL AND SYSTEM AND ASSOCIATED SUBSYSTEM WARRANTY (PICS INCLUDING SUBSYSTEMS)

A. Start Date of the Process instrumentation and control System and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents. The duration of the warranty shall be a minimum of two (2) years.

B. Provide a Warranty Letter stating the Start Date and End Date. This letter shall be included within the O&M Manual

PART III - SEQUENCING AND SCHEDULING

3.01 GENERAL

A. All work provided under this section shall be in accordance with the OWNER/ENGINEER-approved Schedule of Submittal Submissions and Schedule of Values.

B. Specification and Construction Implementation Plan requires phased installation of equipment and systems. Stage all PICS activities (submittals, fabrication, installation, testing, start-up, training, etc.) to support the construction sequencing requirements of the project.

C. Wherever language in this section refers to the PICS, the entire installed PICS, the entire PICS, or similar language, it shall be interpreted to apply to the individual phases of the work; except the requirements for the Performance Acceptance Test (PAT).

D. Key milestone dates associated with PICS activity shall be included in the overall project schedule. Include the following dates as a minimum:

1. FDT start and end date
2. ORT start and end date
3. PAT start and end date
4. Date Configuration System is delivered to the Engineer, if applicable
5. Date Configuration System is expected to be retrieved from the Engineer, if applicable
6. Training dates

3.02 NETWORK COORDINATION MEETING

A. Subsequent to the pre-submittal meeting the ICS shall conduct a network coordination meeting with the owner and engineer.

B. The ICS shall chair and develop an agenda for a meeting which shall address the basic criteria to be adhered to in the configuration and connection of the new process controls into the existing plant control system. As a minimum, this meeting shall address the following issues:

1. Ethernet switch configurations
2. IP addresses to be used
3. Integration into the existing plant control system
4. PLC programming standards

3.03 GRAPHICS COORDINATION MEETINGS

A. Refer to section 17900 for meeting requirements.

3.04 PREREQUISITE ACTIVITIES AND LEAD TIMES:

A. Start the following key Project activities when prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawings submittal prerequisite: Completion of the Pre-submittal conference

2. Test Prerequisite:

   a. All associated process and mechanical equipment, controlled and monitored by the instrumentation and control system, complete in place

   b. Associated test plan submittal approved. For FDT, ORT and PAT, notice of test schedule required 2 weeks prior to the start of test.

3. FDT Prerequisite:

   a. Approved FDT test procedures

   b. Approved FDT test forms

   c. 14 calendar days advance written notice to given to OWNER & Engineer of impending FDT.

4. ORT Prerequisite:

   a. FDT successfully completed.

   b. Approved ORT test procedures

   c. Approved ORT test forms

   d. 14 calendar days advance written notice to given to OWNER & Engineer of impending ORT.

5. PAT Prerequisite:

   a. Application software completed and configuration system shipped to the project site.

   b. ORT successfully completed.

   c. Approved PAT test procedures

   d. 14 calendar days advance written notice to given to OWNER & Engineer of impending PAT.

6. O&M submittal prerequisite: PAT successfully completed.

B. Configuration System Delivery: If applicable, deliver the entire

Configuration System to the programmer's office no sooner than 10 days after pre-submittal conference and no later than 6-months prior to starting ORT.

PART IV - PRODUCTS

4.01 GENERAL

A. Refer to requirements of PICS Subsystem provided in Division-17 Specifications.

4.02 SOURCE QUALITY CONTROL

A. General:

1. Test all PICS elements, both hardware (instruments, components, devices, PLCs, etc.) and specific software, to demonstrate that PICS satisfies all requirements.

2. Factory Demonstration Test "FDT"

   a. Develop and provide forms as required to document FDT. All forms generated shall have provisions for signature by PICS representative and OWNER/Engineer.

   b. Component Inspections and Tests:

      1) Check for proper installation on a component-by-component basis.

      2) Check for proper wiring on a point-to-point basis.

      3) Energize equipment to check for functionality.

   c. Functional testing of the control system including but not limited to
      1) I/O point checkouts

      2) HMI screen layouts

      3) Control System Testing per the Control Philosophy

   d. The OWNER/Engineer reserves the rights for the FDT to be a Witnessed or Unwitnessed Factory Test.

3. On-Site Tests Described Under PART 5 - EXECUTION:

   a. Operational Readiness Tests "ORT".

   b. Performance Acceptance Tests "PAT".

4. Test Format: Cause and effect

    a. Person conducting test initiates an input (cause)

    b. Specific test requirement is satisfied if the correct result (effect) occurs

5. Procedures, Forms, and Checklists:

    a. Conduct all tests in accordance with, and documented on, Engineer/Owner accepted procedures, forms, and checklists.

    b. Describe each test item to be performed.

    c. Have space after each test item description for sign off by appropriate party after satisfactory completion.

6. Required Test Documentation: Test procedures, forms, and checklists. All signed by Engineer and Contractor and reviewed by Owner.

7. Conducting Tests:

    a. All special testing materials and equipment.

    b. Wherever possible, perform tests using actual process variables, equipment, and data.

    c. If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.

    d. Define simulation techniques in test procedures.

    e. For PICS Subsystems for which OWNER provides applications software, provide sufficient temporary software configuring to allow for ORT testing of these subsystems prior to installation of the OWNER's applications software.

8. Engineer will actively participate in the tests. Owner will participate in tests when available.

9. Owner/Engineer reserves the right to test or retest all system functions.

10. Owner's/Engineer's decision will be final regarding acceptability and completeness of all testing.

B. Maintenance of Configuration System:

1. Provide for maintenance of the Configuration System at the programmer's office. Repair or replace failed equipment within two days of notice by OWNER/Engineer/Programmer.

C. Provide field support during testing of installed applications software

PART V - EXECUTION

5.01 EXAMINATION

A. Equipment furnished by Supplier or any other subcontractor and installed by the ICS/Contractor, requires Supplier to observe and advise on installation to extent required to certify that equipment has been properly installed and will perform as required.

B. For equipment not provided by the ICS, but that directly interfaces with the PICS, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of all instrumentation and control devices.
3. Correct control action.
4. Switch settings.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

5.02 INSTALLATION

A. Material and Equipment Installation:

1. Follow manufacturer's installation instructions, unless otherwise indicated or directed by the OWNER/ENGINEER
2. Retain a copy of the manufacturer's instructions at the project site, available for review at all times.

B. Wiring:

1. All wiring connected to PICS components and assemblies shall be in accordance with the requirements of Division 16 and 17 of the Specifications.

5.03 FIELD QUALITY CONTROL

A. General: All requirements listed in Subsection Source Quality Control, above, also apply to this Subsection, Field Quality Control.

B. Onsite Supervision:

1. The ICS Project Site Representative shall supervise and coordinate all onsite PICS activities.

2. The ICS Project Site Representative shall be On-Site during total period required to complete all On-Site PICS activities.

C. Startup and Testing Team:

1. Thoroughly check installation, termination, and adjustment for all PICS Subsystems and their components.

2. Complete On-Site tests.

3. Provide and conduct startup services

4. Complete On-Site training.

D. Sequence of Work: Provide individual ORTs and PATs for individual process equipment where required to support the staged construction and startup of the facility. Coordinate the construction sequencing requirements with the OWNER.

E. Specialty Equipment: For certain components or systems provided under this Section but not manufactured by the ICS, provide services of qualified manufacturer's representative during installation, start-up, testing (both ORT and PAT) and OWNER's training. For example: RTD calibrator, vibration shaker table (which may be furnished/operated by vibration sensor manufacturer representative), pressure calibrator, etc, shall be provided as required.

F. Initial On-Site System Demonstration Tests:

1. Programmable Logic Controllers (PLCs):

a. Test all loop-specific functions and demonstrate all I/O Points.

b. Test all non-loop-specific functions including, but not limited to, the following:

1) Failure Mode and Backup Procedures: Power failure, auto restart, retentive outputs

G. Operational Readiness Test (ORT):

1. Prior to start of the Performance Acceptance Test "PAT", the ICS firm shall inspect, and test the PICS equipment and systems, document the resulting tests performed, implement all corrective actions necessary, perform all associated re-testing, and document that the PICS is installed and ready for operation. Subsequent to the ICS documentation that the PICS is installed and ready for operation, perform jointly with

the OWNER/ENGINEER an ORT on the associated PICS equipment to demonstrate that it is fully operable as required by the Contract Documents.

2. For PICS subsystems where the PLC program is provided by the OWNER/Engineer, provide a temporary program to allow testing of these subsystems.

3. Loop/Component Inspections and Tests:

   a. Check PICS for proper installation, calibration, and adjustment on a loop-by-loop, and component-by-component basis.

   b. Develop and provide forms as required to document ORT. All forms generated shall have provisions for signature by PICS representative.

   c. Develop and provide test form hereinafter called the "Loop Status Report" to organize, track inspection, adjustment, and calibration of each loop. Loop Status Report shall include the following as a minimum:

      1) Project name

      2) Loop number

      3) Tag number for each component

      4) Checkoff/signoffs for each component:

         a) Tag/identification

         b) Installation

         c) Wiring termination

         d) Tubing termination

         e) Calibration/adjustment

      5) Checkoffs/signoffs for each loop:

         a) Panel interface termination

         b) PLC I/O interface terminations

      6) PLC I/O Signals are Operational: Received/sent, processed, adjusted

      7) Total loop operational

      8) Space for comments.

d. Develop and provide test form hereinafter called the "Component Calibration Sheet" to organize, track inspection, adjustment, and calibration of each component (except hand switches, pilot lights, gauges, and similar items) and each PLCs I/O Module. The Component Calibration Sheet shall include the following as a minimum:

   1) Project Name

   2) Loop Number

   3) Component tag number or I/O module number

   4) Manufacturer name

   5) Model number/serial number

   6) Summary of functional requirements. For example:

      a) Indicators

      b) Transmitters/converters, input and output ranges

      c) Computing elements' functions

      d) Controllers, action (direct/reverse) and control modes (P&ID)

      e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual)

      f) PLC I/O modules: input or output

   7) Calibrations, for example, but not limited to:

      a) Analog devices: Actual inputs and output at 0, 25, 50, 75, and 100 percent of span, rising and falling

      b) Discrete Devices: Actual trip points and rest points

      c) Controllers: Mode settings (P&ID)

      d) PLC I/O Modules: Actual inputs or outputs of 0, 25, 50, 75, and 100 percent of span, rising and falling.

   8) Space for comments

e. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at the project site and always make them available to the OWNER/ENGINEER.

f. These inspections and tests, inclusive of the above-described forms, will be spot checked by the OWNER/ENGINEER.

g. The ICS shall implement all corrective measures needed and perform retest on any modified sub-system/component.

h. The Contractor shall claim and validate a thorough ORT was performed successfully and all resulting corrective action measures taken were performed successfully and re-tested successfully. Upon successful completion of the ORT, the Contractor shall submit letter notification to the OWNER/ENGINEER stating that the ORT has been successfully completed. The letter notification shall further state that the ICS is ready to begin the Performance Acceptance Test. Submit all forms upon completion of ORT as required by the OWNER/ENGINEER.

H. Performance Acceptance Tests "PAT":

1. Once the ORT has been successfully completed, perform jointly with the Engineer & OWNER a PAT on the associated PICS to demonstrate that it is operating as required by the Contract Documents. The PAT will employ the OWNER/Engineer/Programmer's PLC application software developed for the project.

2. The cumulative total quantity of calendar days shall be consumed in association and in synch with the overall construction sequence for the project. Any Holidays that occur during the PAT shall result in a corresponding number of days being added to the duration of the PAT. The PAT encompasses the startup and testing period of the instrumentation and control system for the associated process and mechanical equipment that are controlled and monitored by the instrumentation and control system. The PAT shall be conducted using application software developed by the OWNER/Engineer/Programmer. The ICS shall test functions installed in the hard-wired system and the entire associated instrumentation and control system including validating the operation and monitoring and control functions of all instruments, all control devices, all instrument and control components, control functions, alarm functions, monitoring functions, calibration ranges, control/alarm setpoint operations, etc.

3. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis based upon the operating description used by the OWNER/Engineer for PLC application software development.

4. Non-loop specific tests shall be the same as previously required except that the entire installed PICS shall be tested using actual process variables and all functions demonstrated.

5. Perform local and manual tests for each loop before proceeding to remote and automatic modes

6. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed,

exercise and observe devices supplied by Others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible and is approved by the Engineer.

7. Make updated versions of documentation required for PAT available to the OWNER at the project site, both before and during tests.

8. Develop and provide PAT test forms that include the following, at minimum:

   a. Project name

   b. Lists the requirements of the loop

   c. Briefly describes the test

   d. Cites the expected results and the actual results

   e. Provides space for checkoff by witnesses.

9. Make one copy of all O&M manuals available to the OWNER/Engineer at the site both before and during testing.

I. The ICS shall implement all corrective measures needed and perform re-test on any modified system.

5.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

APPENDIX A

INSTRUMENT LIST

17100

Drawing Number	Instrument Tag	Instrument Type	Service Description	Location	Signal Detail	Req. Power Supply	LSA Required	Sunshield Required	Instrument Range	Instrument Setpoint	Isolation Ball Valve Required	Installation Details Ref.	Area Classification	Comments
03-I-601	DEWATER-WW1-LSH-01	Float Type Level Switch	BFP Effluent Lift Station Wet Well Level Switch High	BFP Effluent Lift Station	N/A				NA	6.0 ft		I-151		
03-I-601	DEWATER-WW1-LSH-02	Float Type Level Switch	BFP Effluent Lift Station Wet Well Level Switch High	BFP Effluent Lift Station	N/A				NA	5.5 ft		I-151		
03-I-601	DEWATER-WW1-LSH-03	Float Type Level Switch	BFP Effluent Lift Station Wet Well Level Switch High	BFP Effluent Lift Station	N/A				NA	5.0 ft		I-151		
03-I-601	DEWATER-WW1-LSHH-03	Float Type Level Switch	BFP Effluent Lift Station Wet Well Level Switch High High	BFP Effluent Lift Station	N/A				NA	6.5 ft		I-151		
03-I-601	DEWATER-WW1-LSLL-01	Float Type Level Switch	BFP Effluent Lift Station Wet Well Level Switch Low Low	BFP Effluent Lift Station	N/A				NA	2.25 ft		I-151		
03-I-601	DEWATER-WW1-LIT-01	Radar Level Indicating Transmitter	BFP Effluent Lift Station Wet Well Level Indication	BFP Effluent Lift Station	N/A		YES	YES	0-6.5 ft	NA		I-202		
03-I-601	DEWATER-LSPU1-TS-01	Motor Tempaerature Switch	BFP Effluent Pump No 1 Motor Temperature Switch High	BFP Effluent Lift Station	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
03-I-601	DEWATER-LSPU1-MSH-01	Motor Leak Detection Switch	BFP Effluent Pump No 1 Motor Leak Detection Switch High	BFP Effluent Lift Station	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
03-I-601	DEWATER-LSPU1-PI-01	Pressure Gauge	BFP Effluent Pump No 1 Discharge Pressure	BFP Effluent Lift Station	N/A				0-50 PSI	NA		I-301		
03-I-601	DEWATER-LSPU2-TS-01	Motor Tempaerature Switch	BFP Effluent Pump No 2 Motor Temperature Switch High	BFP Effluent Lift Station	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
03-I-601	DEWATER-LSPU2-MSH-01	Motor Leak Detection Switch	BFP Effluent Pump No 2 Motor Leak Detection Switch High	BFP Effluent Lift Station	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
03-I-601	DEWATER-LSPU2-PI-01	Pressure Gauge	BFP Effluent Pump No 2 Discharge Pressure	BFP Effluent Lift Station	N/A				0-50 PSI	NA		I-301		
03-I-601	DEWATER-LSPU3-TS-01	Motor Tempaerature Switch	BFP Effluent Pump No 3 Motor Temperature Switch High	BFP Effluent Lift Station	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
03-I-601	DEWATER-LSPU3-MSH-01	Motor Leak Detection Switch	BFP Effluent Pump No 3 Motor Leak Detection Switch High	BFP Effluent Lift Station	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
03-I-601	DEWATER-LSPU3-PI-01	Pressure Gauge	BFP Effluent Pump No 3 Discharge Pressure	BFP Effluent Lift Station	N/A				0-50 PSI	NA		I-301		
04-I-601	ARF-FEB1-FIT-01	Magnetic Flow Indicating Transmitter	ARF Bypbass Valve Vault Discharge Flow	Ammonia Removal Facility	N/A		YES	YES	0-2000 GPM	NA		I-101		
04-I-601	ARF-FEB1-LSL-01	Float Type Level Switch	Equalization Basin Level Switch Low	Ammonia Removal Facility	N/A				NA	5.0 ft		I-151		
04-I-601	ARF-FEB1-LIT-01	Radar Level Indicating Transmitter	Equalization Basin Level Indication	Ammonia Removal Facility	N/A		YES	YES	0-20 ft	NA		I-202		
04-I-601	ARF-FEB1-AIT-01	Analytical Indicating Transmitter	Equalization Basin Ammonia Indication	Ammonia Removal Facility	N/A		YES	YES	0-1000 mg/L	NA		I-502		
04-I-601	ARF-TS-001	Tempaerature Switch	Electrical Room HVAC Ambient Temperature Switch High	Ammonia Removal Facility	N/A							[by instrument supplier]		
04-I-601	ARF-MIX3-TS-01	Motor Tempaerature Switch	Equalization Basin Mixer Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[by instrument supplier]		
04-I-601	ARF-PDSH-04-01	Differential Pressure Switch	Electrical Room HVAC AHU-01 Differential Pressure Switch High	Ammonia Removal Facility	N/A				Coordinate with HVAC Supplier	Coordinate with HVAC Supplier		[by instrument supplier]		
04-I-601	ARF-PDSH-05-01	Differential Pressure Switch	Electrical Room HVAC AHU-02 Differential Pressure Switch High	Ammonia Removal Facility	N/A				Coordinate with HVAC Supplier	Coordinate with HVAC Supplier		[by instrument supplier]		
04-I-601	ARF-PDSH-07-01	Differential Pressure Switch	Electrical Room HVAC CFU-01 Differential Pressure Switch High	Ammonia Removal Facility	N/A				Coordinate with HVAC Supplier	Coordinate with HVAC Supplier		[by instrument supplier]		
04-I-602	ARF-LSPU1-PI-01	Pressure Gauge	EQ Transfer Pump No 1 Suction Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-602	ARF-LSPU1-PI-02	Pressure Gauge	EQ Transfer Pump No 1 Discharge Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-602	ARF-LSPU2-PI-01	Pressure Gauge	EQ Transfer Pump No 2 Suction Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-602	ARF-LSPU2-PI-02	Pressure Gauge	EQ Transfer Pump No 2 Discharge Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-602	ARF-LSPU3-PI-01	Pressure Gauge	EQ Transfer Pump No 3 Suction Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-602	ARF-LSPU3-PI-02	Pressure Gauge	EQ Transfer Pump No 3 Discharge Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-602	ARF-LSPU1-TS-01	Motor Temperature Switch	EQ Transfer Pump No 1 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
04-I-602	ARF-LSPU2-TS-01	Motor Temperature Switch	EQ Transfer Pump No 2 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
04-I-602	ARF-LSPU3-TS-01	Motor Temperature Switch	EQ Transfer Pump No 3 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
04-I-604	ARF-NH3R1-ZSO-01	Position Switch Openend	ATR 1 Aeration Distribution Valve Opened Position Switch	Ammonia Removal Facility	N/A							[by valve/gate supplier]		
04-I-604	ARF-NH3R1-ZSC-01	Position Switch Closed	ATR 1 Aeration Distribution Valve Closed Position Switch	Ammonia Removal Facility	N/A							[by valve/gate supplier]		
04-I-604	ARF-NH3R1-FIT-01	Thermal Mass Flow Indicating Transmitter	ATR 1 Aeration Distribution Flow Indication	Ammonia Removal Facility	N/A		YES	YES	0-3000 SCFM	NA		I-102		
04-I-604	ARF-JBX1-LIT-01	Radar Level Indicating Transmitter	ATR 1 Influent Splitter Box Level Indication	Ammonia Removal Facility	N/A		YES	YES	0-20 ft	NA		I-202		
04-I-604	ARF-MIX1A-TS-01	Motor Tempaerature Switch	ATR 1 Mixer No 1 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per motor supplier]		
04-I-604	ARF-MIX1B-TS-01	Motor Tempaerature Switch	ATR 1 Mixer No 2 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per motor supplier]		
04-I-604	ARF-NH3R1-LSH-01	Float Type Level Switch	ATR 1 Instrument Chamber Level Switch High	Ammonia Removal Facility	N/A				NA	3 ft		I-151		
04-I-604	ARF-NH3R1-LSL-01	Float Type Level Switch	ATR 1 Instrument Chamber Level Switch Low	Ammonia Removal Facility	N/A				NA	1 ft		I-151		
04-I-604	ARF-NH3R1-LIT-01	Radar Level Indicating Transmitter	ATR 1 Instrument Chamber Level Indication	Ammonia Removal Facility	N/A		YES	YES	0-10 ft	NA		I-202		
04-I-604	ARF-NH3R1-AIT-01	Analytical Indicating Transmitter	ATR 1 Instrument Chamber pH/Temp Indication	Ammonia Removal Facility	N/A		YES	YES	0-14 (pH)/0-104 deg F	NA		I-504		
04-I-604	ARF-NH3R1-AIT-02	Analytical Indicating Transmitter	ATR 1 Instrument Chamber Dissolved Oxygen Indication	Ammonia Removal Facility	N/A		YES	YES	0-50 mg/L	NA		I-504		
04-I-604	ARF-NH3R1-AIT-03	Analytical Indicating Transmitter	ATR 1 Ammonia Indication	Ammonia Removal Facility	N/A		YES	YES	0-1000 mg/L	NA		I-504		
04-I-604	ARF-CHANN1-LSH-01	Float Type Level Switch	ATR 1 Effluent Chamber Level Switch High	Ammonia Removal Facility	N/A				NA	3 ft		I-151		
04-I-604	ARF-CHANN1-LSL-01	Float Type Level Switch	ATR 1 Effluent Chamber Level Switch Low	Ammonia Removal Facility	N/A				NA	1 ft		I-151		
04-I-604	ARF-CHANN1-LIT-01	Radar Level Indicating Transmitter	ATR 1 Effluent Chamber Level Indication	Ammonia Removal Facility	N/A		YES	YES	0-10 ft	NA		I-202		
04-I-605	ARF-NH3R2-ZSO-01	Position Switch Openend	ATR 2 Aeration Distribution Valve Opened Position Switch	Ammonia Removal Facility	N/A							[by valve/gate supplier]		
04-I-605	ARF-NH3R2-ZSC-01	Position Switch Closed	ATR 2 Aeration Distribution Valve Closed Position Switch	Ammonia Removal Facility	N/A							[by valve/gate supplier]		
04-I-604	ARF-JBX1-LIT-02	Radar Level Indicating Transmitter	ATR 2 Influent Splitter Box Level Indication	Ammonia Removal Facility	N/A		YES	YES	0-20 ft	NA		I-202		
04-I-605	ARF-NH3R2-FIT-01	Thermal Mass Flow Indicating Transmitter	ATR 2 Aeration Distribution Flow Indication	Ammonia Removal Facility	N/A		YES	YES	0-3000 SCFM	NA		I-102		
04-I-605	ARF-MIX2A-TS-01	Motor Tempaerature Switch	ATR 2 Mixer No 1 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per motor supplier]		
04-I-605	ARF-MIX2B-TS-01	Motor Tempaerature Switch	ATR 2 Mixer No 2 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per motor supplier]		
04-I-605	ARF-NH3R2-LIT-01	Radar Level Indicating Transmitter	ATR 2 Instrument Chamber Level Indication	Ammonia Removal Facility	N/A		YES	YES	0-10 ft	NA		I-202		
04-I-605	ARF-NH3R2-AIT-01	Analytical Indicating Transmitter	ATR 2 Instrument Chamber pH/Temp Indication	Ammonia Removal Facility	N/A		YES	YES	0-14 (pH)/0-104 deg F	NA		I-504		
04-I-605	ARF-NH3R2-AIT-02	Analytical Indicating Transmitter	ATR 2 Instrument Chamber Dissolved Oxygen Indication	Ammonia Removal Facility	N/A		YES	YES	0-50 mg/L	NA		I-504		
04-I-605	ARF-NH3R2-AIT-03	Analytical Indicating Transmitter	ATR 2 Ammonia Indication	Ammonia Removal Facility	N/A		YES	YES	0-1000 mg/L	NA		I-504		
04-I-607	ARF-LSPU4-PI-01	Pressure Gauge	ARF Effluent Pump No 1 Suction Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-607	ARF-LSPU4-PI-02	Pressure Gauge	ARF Effluent Pump No 1 Discharge Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-607	ARF-LSPU5-PI-01	Pressure Gauge	ARF Effluent Pump No 2 Suction Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-607	ARF-LSPU5-PI-02	Pressure Gauge	ARF Effluent Pump No 2 Discharge Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-607	ARF-LSPU6-PI-01	Pressure Gauge	ARF Effluent Pump No 3 Suction Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-607	ARF-LSPU6-PI-02	Pressure Gauge	ARF Effluent Pump No 3 Discharge Pressure	Ammonia Removal Facility	N/A				0-50 PSI	NA		I-301		
04-I-607	ARF-LSPU4-TS-01	Motor Temperature Switch	ARF Effluent Pump No 1 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
04-I-607	ARF-LSPU5-TS-01	Motor Temperature Switch	ARF Effluent Pump No 2 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
04-I-607	ARF-LSPU6-TS-01	Motor Temperature Switch	ARF Effluent Pump No 3 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Pump Manufacturer	By Pump Manufacturer		[per motor supplier]		
05-I-601	ARF-BLWR1-PI-01	Pressure Gauge	ARF Blower No 1 Suction Pressure	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR1-PI-02	Pressure Gauge	ARF Blower No 1 Discharge Pressure	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR1-PSL-01	Pressure Switch	ARF Blower No 1 Suction Pressure Switch Low	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR1-PSH-01	Pressure Switch	ARF Blower No 1 Discharge Pressure Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR1-TS-01	Motor Temperature Switch	ARF Blower No 1 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per motor supplier]		
05-I-601	ARF-BLWR1-TS-02	Temperature Switch	ARF Blower No 1 Discharge Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per instrument supplier]		
05-I-601	ARF-BLWR1-TI-01	Temperature Gauge	ARF Blower No 1 Discharge Temperature Indication	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per instrument supplier]		
05-I-601	ARF-BLWR2-PI-01	Pressure Gauge	ARF Blower No 2 Suction Pressure	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR2-PI-02	Pressure Gauge	ARF Blower No 2 Discharge Pressure	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR2-PSL-01	Pressure Switch	ARF Blower No 2 Suction Pressure Switch Low	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR2-PSH-01	Pressure Switch	ARF Blower No 2 Discharge Pressure Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR2-TS-01	Motor Temperature Switch	ARF Blower No 2 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per motor supplier]		
05-I-601	ARF-BLWR2-TS-02	Temperature Switch	ARF Blower No 2 Discharge Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per instrument supplier]		
05-I-601	ARF-BLWR2-TI-01	Temperature Gauge	ARF Blower No 2 Discharge Temperature Indication	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per instrument supplier]		
05-I-601	ARF-BLWR3-PI-01	Pressure Gauge	ARF Blower No 3 Suction Pressure	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR3-PI-02	Pressure Gauge	ARF Blower No 3 Discharge Pressure	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR3-PSL-01	Pressure Switch	ARF Blower No 3 Suction Pressure Switch Low	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR3-PSH-01	Pressure Switch	ARF Blower No 3 Discharge Pressure Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		I-301		
05-I-601	ARF-BLWR3-TS-01	Motor Temperature Switch	ARF Blower No 3 Motor Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per motor supplier]		
05-I-601	ARF-BLWR3-TS-02	Temperature Switch	ARF Blower No 3 Discharge Temperature Switch High	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per instrument supplier]		
05-I-601	ARF-BLWR3-TI-01	Temperature Gauge	ARF Blower No 3 Discharge Temperature Indication	Ammonia Removal Facility	N/A				By Manufacturer	By Manufacturer		[per instrument supplier]		
05-I-601	ARF-AIP1-PIT-01	Pressure Indicating Transmitter	ARF Blowers Discharge Pressure Indication	Ammonia Removal Facility	N/A				0-15 PSI	NA		I-303		
05-I-601	ARF-AIP1-TI-01	Temperature Gauge	ARF Blowers Discharge Temperature Indication	Ammonia Removal Facility	N/A				0-400 deg F	NA		[per instrument supplier]		

APPENDIX B

INPUT/OUTPUT LIST

17900

BFPLCS-CP1-RIO01

AI	1
AO	0
DI	23
DO	3
DSAI	0
DSAO	0
DSDI	0
DSDO	0

IO Tag	I/O Type	Signal Type	Description	PID Drawing No.	Processor Cabinet No.	RACK / BASE	SLOT	I/O POINT	CARD/MODULE TERMINALS	FIELD I/O ADDR *	BIT NO *	EGU LOW	EGU HIGH	EGU	SCALED IN PLC?	RAW LOW	RAW HIGH	SIGNAL TYPE	TERMINAL BLOCK	TERMINAL NO'S	LOOP DIAG	Comments
DEWATER-WW1-LSH-01	DI	24VDC	BFP Effluent Lift Station Wet Well High Level Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-WW1-LSLL-01	DI	24VDC	BFP Effluent Lift Station Wet Well Low Low Level Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-WW1-LSHH-01	DI	24VDC	BFP Effluent Lift Station Wet Well High High Level Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-WW1-LSH-02	DI	24VDC	BFP Effluent Lift Station Wet Well High Level Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-WW1-LSH-03	DI	24VDC	BFP Effluent Lift Station Wet Well High Level Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-WW1-LIT-01	AI	4-20 mA	BFP Effluent Lift Station Wet Well Level Indication	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU1-HS-01	DO	24VDC	BFP Effluent Pump No 1 Start/Stop Command	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU1-YL-01A	DI	24VDC	BFP Effluent Pump No 1 In Remote Status	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU1-YL-01B	DI	24VDC	BFP Effluent Pump No 1 Running Status	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU1-YA-01A	DI	24VDC	BFP Effluent Pump No 1 Fault Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU1-YA-01B	DI	24VDC	BFP Effluent Pump No 1 E-Stop Initiated Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU1-MSH-01	DI	24VDC	BFP Effluent Pump No 1 Motor Moisture Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU1-TS-01	DI	24VDC	BFP Effluent Pump No 1 Motor Temperature Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU2-HS-01	DO	24VDC	BFP Effluent Pump No 2 Start/Stop Command	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU2-YL-01A	DI	24VDC	BFP Effluent Pump No 2 In Remote Status	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU2-YL-01B	DI	24VDC	BFP Effluent Pump No 2 Running Status	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU2-YA-01A	DI	24VDC	BFP Effluent Pump No 2 Fault Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU2-YA-01B	DI	24VDC	BFP Effluent Pump No 2 E-Stop Initiated Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU2-MSH-01	DI	24VDC	BFP Effluent Pump No 2 Motor Moisture Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU2-TS-01	DI	24VDC	BFP Effluent Pump No 2 Motor Temperature Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU3-HS-01	DO	24VDC	BFP Effluent Pump No 3 Start/Stop Command	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU3-YL-01A	DI	24VDC	BFP Effluent Pump No 3 In Remote Status	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU3-YL-01B	DI	24VDC	BFP Effluent Pump No 3 Running Status	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU3-YA-01A	DI	24VDC	BFP Effluent Pump No 3 Fault Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU3-YA-01B	DI	24VDC	BFP Effluent Pump No 3 E-Stop Initiated Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU3-MSH-01	DI	24VDC	BFP Effluent Pump No 3 Motor Moisture Alarm	03-I-601	BFPLS-CP1-RIO01																	
DEWATER-LSPU3-TS-01	DI	24VDC	BFP Effluent Pump No 3 Motor Temperature Alarm	03-I-601	BFPLS-CP1-RIO01																	

ARF-CP1-PLC-01

AI	9
AO	3
DI	27
DO	4
DSAI	0
DSAO	0
DSDI	0
DSDO	0

IO Tag	I/O Type	Signal Type	Description	PID Drawing No.	Processor Cabinet No.	RACK / BASE	SLOT	I/O POINT	CARD/MODULE TERMINALS	FIELD I/O ADDR *	BIT NO *	EGU LOW	EGU HIGH	EGU	SCALED IN PLC?	RAW LOW	RAW HIGH	SIGNAL TYPE	TERMINAL BLOCK	TERMINAL NO'S	LOOP DIAG	Comments
ARF-YL-CP-01	DI	24VDC	ARF-CP-01 UPS ON Status	04-I-601	ARF-CP1-PLC-01																	
ARF-XA-CP-01	DI	24VDC	ARF-CP-01 UPS Battery Low Voltage Status	04-I-601	ARF-CP1-PLC-01																	
ARF-YA-CP-01	DI	24VDC	ARF-CP-01 UPS Fail Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-FEB1-FIT-01	AI	4-20 mA	ARF Bypass Valve Vault Discharge Flow Indication	04-I-601	ARF-CP1-PLC-01																	
ARF-FEB1-LSL-01	DI	24VDC	ARF Equalization Basin Low Level Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-MIX3-HS-01	DO	24VDC	ARF Equalization Basin Mixer Start/Stop Command	04-I-601	ARF-CP1-PLC-01																	
ARF-MIX3-YL-01A	DI	24VDC	ARF Equalization Basin Mixer In Remote Status	04-I-601	ARF-CP1-PLC-01																	
ARF-MIX3-YL-01B	DI	24VDC	ARF Equalization Basin Mixer Running Status	04-I-601	ARF-CP1-PLC-01																	
ARF-MIX3-YA-01A	DI	24VDC	ARF Equalization Basin Mixer Fault Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-MIX3-YA-01B	DI	24VDC	ARF Equalization Basin Mixer E-Stop Initiated Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-MIX3-TS-01	DI	24VDC	ARF Equalization Basin Mixer Motor Temperature Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-TS-001	DI	24VDC	Electrical Room HVAC Ambient Temperature Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-YA-001	DI	24VDC	Electrical Room HVAC AHU-01 Fault Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-PDSH-001	DI	24VDC	Electrical Room HVAC AHU-01 Dirty Filter Differential Pressure Alarm High	04-I-601	ARF-CP1-PLC-01																	
ARF-YA-002	DI	24VDC	Electrical Room HVAC AHU-02 Fault Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-PDSH-002	DI	24VDC	Electrical Room HVAC AHU-02 Dirty Filter Differential Pressure Alarm High	04-I-601	ARF-CP1-PLC-01																	
ARF-PDSH-003	DI	24VDC	Electrical Room HVAC CFU-01 Dirty Filter Differential Pressure Alarm High	04-I-601	ARF-CP1-PLC-01																	
ARF-FEB1-LIT-01	AI	4-20 mA	ARF Equalization Basin Level Indication	04-I-601	ARF-CP1-PLC-01																	
ARF-FEB1-AIT-01	AI	4-20 mA	ARF Equalization Basin NH3 Indication	04-I-601	ARF-CP1-PLC-01																	
ARF-LSPU1-HS-01	DO	24VDC	ARF EQ Transfer Pump No 1 Start/Stop Command	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-YL-01A	DI	24VDC	ARF EQ Transfer Pump No 1 In Remote Status	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-SK-01	AO	4-20 mA	ARF EQ Transfer Pump No 1 Speed Control	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-SI-01	AI	4-20 mA	ARF EQ Transfer Pump No 1 Speed Indication	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-YL-01B	DI	24VDC	ARF EQ Transfer Pump No 1 Running Status	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-YA-01A	DI	24VDC	ARF EQ Transfer Pump No 1 Fault Alarm	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-YA-01B	DI	24VDC	ARF EQ Transfer Pump No 1 E-Stop Initiated Alarm	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-II-01	AI	4-20 mA	ARF EQ Transfer Pump No 1 Current Indication	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU1-TAH-01	DI	24VDC	ARF EQ Transfer Pump No 1 Motor Temperature Alarm	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-HS-01	DO	24VDC	ARF EQ Transfer Pump No 2 Start/Stop Command	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-YL-01A	DI	24VDC	ARF EQ Transfer Pump No 2 In Remote Status	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-SK-01	AO	4-20 mA	ARF EQ Transfer Pump No 2 Speed Control	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-SI-01	AI	4-20 mA	ARF EQ Transfer Pump No 2 Speed Indication	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-YL-01B	DI	24VDC	ARF EQ Transfer Pump No 2 Running Status	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-YA-01A	DI	24VDC	ARF EQ Transfer Pump No 2 Fault Alarm	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-YA-01B	DI	24VDC	ARF EQ Transfer Pump No 2 E-Stop Initiated Alarm	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-II-01	AI	4-20 mA	ARF EQ Transfer Pump No 2 Current Indication	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU2-TAH-01	DI	24VDC	ARF EQ Transfer Pump No 2 Motor Temperature Alarm	04-I-602	ARF-CP1-PLC-01																	
ARF-LSPU3-HS-01	DO	24VDC	ARF EQ Transfer Pump No 3 Start/Stop Command	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-YL-01A	DI	24VDC	ARF EQ Transfer Pump No 3 In Remote Status	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-SK-01	AO	4-20 mA	ARF EQ Transfer Pump No 3 Speed Control	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-SI-01	AI	4-20 mA	ARF EQ Transfer Pump No 3 Speed Indication	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-YL-01B	DI	24VDC	ARF EQ Transfer Pump No 3 Running Status	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-YA-01A	DI	24VDC	ARF EQ Transfer Pump No 3 Fault Alarm	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-YA-01B	DI	24VDC	ARF EQ Transfer Pump No 3 E-Stop Initiated Alarm	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-II-01	AI	4-20 mA	ARF EQ Transfer Pump No 3 Current Indication	04-I-603	ARF-CP1-PLC-01																	
ARF-LSPU3-TAH-01	DI	24VDC	ARF EQ Transfer Pump No 3 Motor Temperature Alarm	04-I-603	ARF-CP1-PLC-01																	

ARF-CP2-PLC-01

AI	32
AO	11
DI	81
DO	10
DSAI	0
DSAO	0
DSDI	0
DSDO	0

IO Tag	I/O Type	Signal Type	Description	PID Drawing No.	Processor Cabinet No.	RACK / BASE	SLOT	I/O POINT	CARD/MODULE TERMINALS	FIELD I/O ADDR *	BIT NO *	EGU LOW	EGU HIGH	EGU	SCALED IN PLC?	RAW LOW	RAW HIGH	SIGNAL TYPE	TERMINAL BLOCK	TERMINAL NO'S	LOOP DIAG	Comments
ARF-YL-CP-02	DI	24VDC	ARF-CP-02 UPS ON Status	04-I-601	ARF-CP1-PLC-01																	
ARF-XA-CP-02	DI	24VDC	ARF-CP-02 UPS Battery Low Voltage Status	04-I-601	ARF-CP1-PLC-01																	
ARF-YA-CP-02	DI	24VDC	ARF-CP-02 UPS Fail Alarm	04-I-601	ARF-CP1-PLC-01																	
ARF-NH3R1-ZK-01	AO	4-20 mA	ATR 1 Aeration Distribution Valve Position Command	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-YL-01	DI	24VDC	ATR 1 Aeration Distribution Valve Ready Status	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-ZLO-01	DI	24VDC	ATR 1 Aeration Distribution Valve Opened Status	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-ZLC-01	DI	24VDC	ATR 1 Aeration Distribution Valve Closed Status	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-NAHH-01	DI	24VDC	ATR 1 Aeration Distribution Valve Torque Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-ZI-01	AI	4-20 mA	ATR 1 Aeration Distribution Valve Position Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-FIT-01	AI	4-20 mA	ATR 1 Aeration Distribution Flow Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-HS-01	DO	24VDC	ATR 1 Mixer No 1 Start/Stop Command	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-YL-01A	DI	24VDC	ATR 1 Mixer No 1 In Remote Status	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-SK-01	AO	4-20 mA	ATR 1 Mixer No 1 Speed Control	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-SI-01	AI	4-20 mA	ATR 1 Mixer No 1 Speed Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-YL-01B	DI	24VDC	ATR 1 Mixer No 1 Running Status	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-YA-01A	DI	24VDC	ATR 1 Mixer No 1 Fault Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-YA-01B	DI	24VDC	ATR 1 Mixer No 1 E-Stop Initiated Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-II-01	AI	4-20 mA	ATR 1 Mixer No 1 Current Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1A-TAH-01	DI	24VDC	ATR 1 Mixer No 1 Motor Temperature Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-HS-01	DO	24VDC	ATR 1 Mixer No 2 Start/Stop Command	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-YL-01A	DI	24VDC	ATR 1 Mixer No 2 In Remote Status	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-SK-01	AO	4-20 mA	ATR 1 Mixer No 2 Speed Control	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-SI-01	AI	4-20 mA	ATR 1 Mixer No 2 Speed Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-YL-01B	DI	24VDC	ATR 1 Mixer No 2 Running Status	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-YA-01A	DI	24VDC	ATR 1 Mixer No 2 Fault Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-YA-01B	DI	24VDC	ATR 1 Mixer No 2 E-Stop Initiated Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-II-01	AI	4-20 mA	ATR 1 Mixer No 2 Current Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-MIX1B-TAH-01	DI	24VDC	ATR 1 Mixer No 2 Motor Temperature Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-LSH-01	DI	24VDC	ATR 1 Instrument Chamber High Level Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-LSL-01	DI	24VDC	ATR 1 Instrument Chamber Low Level Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-LIT-01	AI	4-20 mA	ATR 1 Instrument Chamber Level Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-AIT-01	AI	4-20 mA	ATR 1 Instrument Chamber Ph/Temp Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R1-AIT-02	AI	4-20 mA	ATR 1 Instrument Chamber DO Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-CHANN1-LSH-01	DI	24VDC	ATR 1 ARF Effluent Chamber High Level Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-CHANN1-LSL-01	DI	24VDC	ATR 1 ARF Effluent Chamber Low Level Alarm	04-I-604	ARF-CP2-PLC-01																	
ARF-CHANN1-LIT-01	AI	4-20 mA	ATR 1 ARF Effluent Chamber Level Indication	04-I-604	ARF-CP2-PLC-01																	
ARF-NH3R2-ZK-01	AO	4-20 mA	ATR 2 Aeration Distribution Valve Position Command	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-YL-01	DI	24VDC	ATR 2 Aeration Distribution Valve Ready Status	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-ZLO-01	DI	24VDC	ATR 2 Aeration Distribution Valve Opened Status	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-ZLC-01	DI	24VDC	ATR 2 Aeration Distribution Valve Closed Status	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-NAHH-01	DI	24VDC	ATR 2 Aeration Distribution Valve Torque Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-ZI-01	AI	4-20 mA	ATR 2 Aeration Distribution Valve Position Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-FIT-01	AI	4-20 mA	ATR 2 Aeration Distribution Flow Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-HS-01	DO	24VDC	ATR 2 Mixer No 1 Start/Stop Command	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-YL-01A	DI	24VDC	ATR 2 Mixer No 1 In Remote Status	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-SK-01	AO	4-20 mA	ATR 2 Mixer No 1 Speed Control	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-SI-01	AI	4-20 mA	ATR 2 Mixer No 1 Speed Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-YL-01B	DI	24VDC	ATR 2 Mixer No 1 Running Status	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-YA-01A	DI	24VDC	ATR 2 Mixer No 1 Fault Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-YA-01B	DI	24VDC	ATR 2 Mixer No 1 E-Stop Initiated Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-II-01	AI	4-20 mA	ATR 2 Mixer No 1 Current Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2A-TAH-01	DI	24VDC	ATR 2 Mixer No 1 Motor Temperature Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-HS-01	DO	24VDC	ATR 2 Mixer No 2 Start/Stop Command	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-YL-01A	DI	24VDC	ATR 2 Mixer No 2 In Remote Status	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-SK-01	AO	4-20 mA	ATR 2 Mixer No 2 Speed Control	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-SI-01	AI	4-20 mA	ATR 2 Mixer No 2 Speed Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-YL-01B	DI	24VDC	ATR 2 Mixer No 2 Running Status	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-YA-01A	DI	24VDC	ATR 2 Mixer No 2 Fault Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-YA-01B	DI	24VDC	ATR 2 Mixer No 2 E-Stop Initiated Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-II-01	AI	4-20 mA	ATR 2 Mixer No 2 Current Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-MIX2B-TAH-01	DI	24VDC	ATR 2 Mixer No 2 Motor Temperature Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-LSH-01	DI	24VDC	ATR 2 Instrument Chamber High Level Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-LSL-01	DI	24VDC	ATR 2 Instrument Chamber Low Level Alarm	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-LIT-01	AI	4-20 mA	ATR 2 Instrument Chamber Level Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-AIT-01	AI	4-20 mA	ATR 2 Instrument Chamber Ph/Temp Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R2-AIT-02	AI	4-20 mA	ATR 2 Instrument Chamber DO Indication	04-I-605	ARF-CP2-PLC-01																	
ARF-NH3R1-AIT-03	AI	4-20 mA	ATR 1 NH3 Indication	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-LIT-01	AI	4-20 mA	ATR 1 Influent Splitter Box Level Indication	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZK-01	AO	4-20 mA	ATR 1 Influent Splitter Box Gate Position Command	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-YL-01	DI	24VDC	ATR 1 Influent Splitter Box Gate Ready Status	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZLO-01	DI	24VDC	ATR 1 Influent Splitter Box Gate Opened Status	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZLC-01	DI	24VDC	ATR 1 Influent Splitter Box Gate Closed Status	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-NAHH-01	DI	24VDC	ATR 1 Influent Splitter Box Gate Torque Alarm	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZI-01	AI	4-20 mA	ATR 1 Influent Splitter Box Gate Position Indication	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZK-02	AO	4-20 mA	ATR 2 Influent Splitter Box Gate Position Command	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-YL-02	DI	24VDC	ATR 2 Influent Splitter Box Gate Ready Status	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZLO-02	DI	24VDC	ATR 2 Influent Splitter Box Gate Opened Status	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZLC-02	DI	24VDC	ATR 2 Influent Splitter Box Gate Closed Status	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-NAHH-02	DI	24VDC	ATR 2 Influent Splitter Box Gate Torque Alarm	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-ZI-02	AI	4-20 mA	ATR 2 Influent Splitter Box Gate Position Indication	04-I-606	ARF-CP2-PLC-01																	
ARF-JBX1-LIT-02	AI	4-20 mA	ATR 2 NH3 Indication	04-I-606	ARF-CP2-PLC-01																	
ARF-NH3R2-AIT-03	AI	4-20 mA	ATR 2 Influent Splitter Box Level Indication	04-I-606	ARF-CP2-PLC-01																	
ARF-LSPU4-HS-01	DO	24VDC	ARF Effluent Pump No 1 Start/Stop Command	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU4-YL-01A	DI	24VDC	ARF Effluent Pump No 1 In Remote Status	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU4-YL-01B	DI	24VDC	ARF Effluent Pump No 1 Running Status	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU4-YA-01A	DI	24VDC	ARF Effluent Pump No 1 Fault Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU4-YA-01B	DI	24VDC	ARF Effluent Pump No 1 E-Stop Initiated Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU4-TS-01	DI	24VDC	ARF Effluent Pump No 1 Motor Temperature Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU5-HS-01	DO	24VDC	ARF Effluent Pump No 2 Start/Stop Command	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU5-YL-01A	DI	24VDC	ARF Effluent Pump No 2 In Remote Status	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU5-YL-01B	DI	24VDC	ARF Effluent Pump No 2 Running Status	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU5-YA-01A	DI	24VDC	ARF Effluent Pump No 2 Fault Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU5-YA-01B	DI	24VDC	ARF Effluent Pump No 2 E-Stop Initiated Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU5-TS-01	DI	24VDC	ARF Effluent Pump No 2 Motor Temperature Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU6-HS-01	DO	24VDC	ARF Effluent Pump No 3 Start/Stop Command	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU6-YL-01A	DI	24VDC	ARF Effluent Pump No 3 In Remote Status	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU6-YL-01B	DI	24VDC	ARF Effluent Pump No 3 Running Status	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU6-YA-01A	DI	24VDC	ARF Effluent Pump No 3 Fault Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU6-YA-01B	DI	24VDC	ARF Effluent Pump No 3 E-Stop Initiated Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-LSPU6-TS-01	DI	24VDC	ARF Effluent Pump No 3 Motor Temperature Alarm	04-I-607	ARF-CP2-PLC-01																	
ARF-BLWR1-HS-01	DO	24VDC	ARF Air Blower No 1 Start/Stop Command	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-YL-01A	DI	24VDC	ARF Air Blower No 1 In Remote Status	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-SK-01	AO	4-20 mA	ARF Air Blower No 1 Speed Control	05-I-601	ARF-CP2-PLC-01																	

ARF-CP2-PLC-01

AI	32
AO	11
DI	81
DO	10
DSAI	0
DSAO	0
DSDI	0
DSDO	0

IO Tag	I/O Type	Signal Type	Description	PID Drawing No.	Processor Cabinet No.	RACK / BASE	SLOT	I/O POINT	CARD/MODULE TERMINALS	FIELD I/O ADDR *	BIT NO *	EGU LOW	EGU HIGH	EGU	SCALED IN PLC?	RAW LOW	RAW HIGH	SIGNAL TYPE	TERMINAL BLOCK	TERMINAL NO'S	LOOP DIAG	Comments
ARF-BLWR1-SI-01	AI	4-20 mA	ARF Air Blower No 1 Speed Indication	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-YL-01B	DI	24VDC	ARF Air Blower No 1 Running Status	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-YA-01A	DI	24VDC	ARF Air Blower No 1 Fault Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-YA-01B	DI	24VDC	ARF Air Blower No 1 E-Stop Initiated Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-II-01	AI	4-20 mA	ARF Air Blower No 1 Current Indication	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-TAH-01A	DI	24VDC	ARF Air Blower No 1 Motor Temperature Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-PAL-01	DI	24VDC	ARF Air Blower No 1 Suction Low Pressure Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-PAH-01	DI	24VDC	ARF Air Blower No 1 Discharge High Pressure Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR1-TAH-01B	DI	24VDC	ARF Air Blower No 1 Discharge High Temperature Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-HS-01	DO	24VDC	ARF Air Blower No 2 Start/Stop Command	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-YL-01A	DI	24VDC	ARF Air Blower No 2 In Remote Status	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-SK-01	AO	4-20 mA	ARF Air Blower No 2 Speed Control	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-SI-01	AI	4-20 mA	ARF Air Blower No 2 Speed Indication	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-YL-01B	DI	24VDC	ARF Air Blower No 2 Running Status	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-YA-01A	DI	24VDC	ARF Air Blower No 2 Fault Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-YA-01B	DI	24VDC	ARF Air Blower No 2 E-Stop Initiated Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-II-01	AI	4-20 mA	ARF Air Blower No 2 Current Indication	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-TAH-01A	DI	24VDC	ARF Air Blower No 2 Motor Temperature Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-PAL-01	DI	24VDC	ARF Air Blower No 2 Suction Low Pressure Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-PAH-01	DI	24VDC	ARF Air Blower No 2 Discharge High Pressure Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR2-TAH-01B	DI	24VDC	ARF Air Blower No 2 Discharge High Temperature Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-HS-01	DO	24VDC	ARF Air Blower No 3 Start/Stop Command	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-YL-01A	DI	24VDC	ARF Air Blower No 3 In Remote Status	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-SK-01	AO	4-20 mA	ARF Air Blower No 3 Speed Control	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-SI-01	AI	4-20 mA	ARF Air Blower No 3 Speed Indication	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-YL-01B	DI	24VDC	ARF Air Blower No 3 Running Status	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-YA-01A	DI	24VDC	ARF Air Blower No 3 Fault Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-YA-01B	DI	24VDC	ARF Air Blower No 3 E-Stop Initiated Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-II-01	AI	4-20 mA	ARF Air Blower No 3 Current Indication	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-TAH-01A	DI	24VDC	ARF Air Blower No 3 Motor Temperature Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-PAL-01	DI	24VDC	ARF Air Blower No 3 Suction Low Pressure Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-PAH-01	DI	24VDC	ARF Air Blower No 3 Discharge High Pressure Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-BLWR3-TAH-01B	DI	24VDC	ARF Air Blower No 3 Discharge High Temperature Alarm	05-I-601	ARF-CP2-PLC-01																	
ARF-AIP1-PIT-01	AI	4-20 mA	ARF Air Blower Discharge Common Header Pressure Indication	05-I-601	ARF-CP2-PLC-01																	

PART I - GENERAL

1.01 THE REQUIREMENT

A. General: The CONTRACTOR shall furnish and install all in-line liquid flow measuring systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to this Section.

1.02 CONTRACTOR SUBMITTALS

A. General: The CONTRACTOR shall furnish submittals in accordance with Section 17100 - Process Control and Instrumentation Systems.

1.03 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

1.04 MANUFACTURER'S REPRESENTATIVE SERVICES

A. General: Manufacturers representative services shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

1.05 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

1.06 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

PART II - PRODUCTS

2.01 GENERAL:

A. All devices specified herein shall conform to the requirements of the Contract Documents.

2.02 MAGNETIC FLOW MEASURING SYSTEMS

A. Magnetic Flowmeter (Tube Type):

1. Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC pulsed signal directly proportional to and linear with the liquid flow rate. Complete zero stability shall be an inherent characteristic of the flowmeter system. Each magnetic flow metering system shall include a metering tube, signal cable, and transmitter. The metering tube shall be constructed of 304 stainless steel with flanged connections, have at least 2 diametrically opposed, bullet-nosed, self cleaning electrodes, a liner material recommended by the manufacturer for the meter's intended service as described in these documents, a meter housing rated for NEMA 6 submergence conditions, and a meter coating consisting of epoxy painted finish.

2. The signal converter/transmitter shall use a DC pulse technique to drive flux-producing coils and convert the DC pulse signal from the tube to a 4-20 mA signal. The signal converter/transmitter shall have a backlit alphanumeric display housed in a NEMA 4X enclosure. It shall have integral zero return to provide a constant zero output signal in response to an external dry contact closure, an integral calibration self-test feature to verify proper operation of the electronics, high and low alarms and an automatic zero adjustment. The transmitter installation shall support integral or remote mounting (up to 300ft). Meter package shall include (2) corrosion resistant grounding rings constructed of the same material as the electrodes.

3. The meter shall be equipped with non-removable electrodes constructed of Hastelloy C. The meter shall support measurement and totalization of bi-directional flow. Installation parameters shall be as follows:

    a. Minimum 5 pipe diameters of straight pipe upstream

    b. Minimum 2 pipe diameters of straight pipe downstream

    c. Horizontal mounting only

    d. Support for lines sizes from 1-inch to 120-inches

4. Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the US National Bureau of Standards. The calibration procedure shall conform to the requirements of MIL-STD-45662A and/or the more recent ANSI/NCSL Z540-1 or ISO 10012-1 requirements. A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 20, 40, 60, 80, and 100 percent of the calibrated range shall be submitted to the Engineer at least 14 days prior to shipment of the meters to the project site.

5. The flow metering system shall conform to the following technical specifications:

Output: 1. 4-20mA

2. Scaled pulsed output for totalization

3. HART protocol compatible

Accuracy: ± 0.25% of flow rate from 10 to 100% full scale

Repeatability: ± 0.05% at ± 0.0008 ft/s

Environmental Limits: - 10 to + 60º C

Power Consumption: 20VA or less

Power Requirements: 110 VAC or 24Vdc, +/- 10%

Accessories:

a. Furnish and install stainless steel sunshield for outdoor/exposed transmitter.

b. Furnish remote mount flow transmitter with a minimum cable length of 50 feet where indicated on contract drawings.

c. Provide stainless steel stanchions for mounting of remote transmitter no less than 4 feet above grade (reference mounting details on Installation Detail sheets).

d. Provide manufacturer digital calibration verification unit with necessary accessories to interface with the furnished magnetic flow meter.

e. Furnish one spool piece for every size magmeter supplied.

f. Furnish and install grounding rings.

6. Magnetic flow measuring systems shall be as manufactured by:

a. Proline Promag W 400 by Endress+Hauser

2.03 INSERTION TYPE THERMAL MASS FLOW METERS

A. Meter assembly shall consist of an insert-type air flow sensor, Nema 4X transmitter with local display, flanged flow conditioner spool piece and all appurtences required to meet the manufacturer installation requirements.

B. The system shall automatically determine the mass flow rate past the sensing points through comparison of the temperatures at the heated and unheated RTDs. The flow conditioner spool piece shall be designed to minimize flow profile irregularities (i.e., swirl) with minimum system pressure loss. Spool piece material and diameter shall match process pipe with minimum length of 8 nominal pipe diameters per manufacturer requirements.

C. The flow element shall be constructed of 316 stainless steel with a 3/4-inch stainless steel male NPT compression fitting process connection. The sensor shall be rated for 0-250 psig at -40° C to 177° C. The sensor shall have a field adjustable length of 1- to 21-inches. The transmitter shall be housed within a powder-coated aluminum Nema 4X enclosure and shall have an LCD display indicating flow rate and temperature. The transmitter shall output an isolated 4-20mA signal proportional to the measured air flow and may be remotely mounted up to 500-feet from the sensor. Input power shall be 120 VAC. Accuracy shall be ±1 percent of reading. Repeatability shall be ±0.5 percent of reading. The unit shall have an adjustable field turndown from 10:1 to 100:1 within calibrated flow range. The transmitter shall have an integral RS-232 port, shall be furnished with a handheld programmer and shall be HART protocol compliant.

D. All hardware and accessories necessary for mounting the probes, transmitters and spool piece shall be provided.

E. Manufacturer shall furnish all electrical cables necessary to connect the sensor probe to the transmitter.

F. The thermal mass flow meter shall be as manufactured by:

1. FCI Model ST51 with VMR flow conditioner and Model FC88 hand-held plug-in interface with manufacturer serial interface cable.

2. Sierra FlatTrak 780S with configuration software and manufacturer serial interface cable for laptop connection.

G. All instrument fittings shall be leak tested at maximum system pressure prior to system performance testing.

PART III - EXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.05 PRECOMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. On-site supervision shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. On-site performance tests shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record drawings shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.09 TRAINING

A. Training shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

3.10 ACCEPTANCE

A. Acceptance shall conform to the requirements of Section 17100 - Process Control and Instrumentation Systems.

END OF SECTION

PART I - GENERAL

1.01 THE REQUIREMENT

A. General: The CONTRACTOR shall provide pressure gauges, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to this Section.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 17100 - Process Control and Instrumentation Systems.

B. Submit product information cut sheets containing manufacturer's specifications, Operations and maintenance data, instrument enclosure type, installation location, and process pressure range to be supplied. Indicate product part number in full.

C. Provide submittals in accordance with Section 01300, and elsewhere in the Contract Documents.

PART II - PRODUCTS

2.01 PRESSURE GAUGES

A. Pressure gauges shall be 4-1/2 inches in diameter, liquid-filled bottom connected, with white laminated dials and black graduations. Windows shall be shatterproof glass acrylic. Gauges shall have a blowout disc and be encased in phenolic, steel, or cast iron. Measuring element shall be a stainless steel bourdon tube with welded, stress-relieved joints. Socket shall have wrench flats. Movements shall be rotary geared stainless steel material. Pressure gauges shall be provided with a pulsation snubber constructed of 316 stainless steel and an isolation valve. Gauges shall be calibrated to read in applicable units. Accuracy shall be plus and minus ½ percent range to 150 percent of the working pressure or vacuum of the pipe or vessel to which they are connected.

B. Pressure gauge ranges shown on the Instrumentation Schedule in the drawings are approximate and shall be coordinated with the equipment where the pressure is being monitored.

C. Provide diaphragm seals for pressure gauges that are connected to process types that contain sewage, sludge, liquids containing solids, pulsating flows or chemical solutions. Seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing. Type 316 stainless steel nuts and bolts. Fill connection and valved flush port size ¼ inch NPT, capable of disassembly without the loss of filler fluid. Fill fluids shall be rated for plus and minus

20% of the rated ambient temperature which is typically -20°C to 50°C for outdoors and 0°C to 50°C for indoors. The fill fluid rating would then typically be as a minimum -35°C to 65°C for outdoors and -10°C to 60°C for indoors.

D. Diaphragms for sewage, sludge and liquids containing solids shall be 316 stainless steel for pressures above 15 psi and elastomer for pressures below 15 psi. Diaphragms shall be Ashcroft model 101, Rosemount model 1199 or approved equal.

E. For chemical solutions, seals shall have a PVC body for removable mounting at 200 psi, with type 316 stainless steel bolts and nuts, ½ inch inlet and ¼ inch outlet, liquid filled with a Teflon diaphragm for pressure and suitable elastomer diaphragm for vacuum service. Diaphragms shall be by Plast-O-Matic Valves, Inc. or approved equal.

F. Each unit provided without a diaphragm seal shall be provided with a factory-installed two-valve manifold. For differential-pressure pressure gauges, each unit shall be provided with factory-installed three-valve manifold. Manifolds shall be 316 stainless steel with PTFE packing.

PART III - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed and connected as specified and shown on the drawings. Contractor shall coordinate with mechanical and piping to insure proper connection to piping and/or other mechanical equipment.

3.02 ACCEPTANCE

A. As a condition precedent to final acceptance of the work, the contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's guarantee.

END OF SECTION

PART I - GENERAL

1.0 SCOPE

A. Provide all labor, materials, and equipment to design, furnish, install, calibrate, test, adjust, and place in operation the facility monitoring, and control system as specified herein and as shown on the PLANS.

B. This Section covers the instrument and control cabinets or modifications to existing cabinets for which components shall be furnished, installed, and put into satisfactory service.

C. Extensive field verification is required for all modifications to existing control panels. The ICS shall include effort associated with field verifying spatial dimensions inside the existing control panels for proposed equipment, wiring terminations, loop power supply sizes, loads on existing instrument loops, points of connections to existing equipment, etc. as required to support the proposed modification effort associated with this project. The ICS shall field locate proposed equipment to be installed inside the existing control panel as shown on the PLANS. The proposed location shall be coordinated with the arrangement of the existing control panel internal and external mounted components.

D. The ICS contractor shall perform field verification from beginning termination point to final termination point. Submit documentation stating current layout.

1.1 RELATED REQUIREMENTS

A. Refer to Section 17100

B. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.2 SUBMITTALS

A. Submit the following in accordance with the Section 01300 and Section 01730 of the Contract Specification and Specification Section 17100:

1. Shop drawings and product data.

2. Operation and maintenance manuals.

B. Notify the ENGINEER/OWNER in writing, at the time of submittal, of any deviations in the submittal(s) from the requirements as specified with in the

Contract Documents. If deviations are not noted, CONTRACTOR assumes responsibility for corrective action.

C. The review and approval of submittals by the ENGINEER/OWNER does not relieve the CONTRACTOR from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission in submittals prepared by CONTRACTOR are assumed by the CONTRACTOR and therefore, the ENGINEER/OWNER shall have no responsibility.

D. The contractor shall submit demolition and renovation drawings of the existing cabinets/enclosures for approval prior to commencement of any work inside the existing cabinets/enclosures. Submittal shall include, but not be limited to, elevations, back panel views, device panel views, equipment arrangement, parts list, bill of material, interconnect wiring diagrams, etc.

1.3 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each Control and PLC and Communication cabinets in conformance with the specifications:

1. One set (10% spare, maximum 6) of Circuit Breaker Overcurrent Protection Devices for each type and size used.

2. Ten (10) fuses for each type and size used.

3. Four (4) control relay assemblies for each type specified and used. Each assembly shall be fully assembled and furnished complete with:

   a. Relay coil and contacts

   b. Relay base

   c. Relay manufacturer's Transient Voltage Suppression module, if utilized

   d. Additional contacts module, if utilized

4. 25% spare (maximum 4) timing relays, each complete with the relay socket base assembly, of each type used.

5. 25% spare (maximum 4) complete single input single output Instrument Loop Current Isolators (I/I Converters), of each type used.

6. 25% spare (maximum 4) surge protectors, of each type used.

7. 25% spare (maximum of 3 per type) contact blocks for pushbuttons and/or selector switches, of each type used.

8. 25% of spare (maximum 4 per type) lenses and lamps for each type and color.

9. Two (2) 24VDC power supplies and one (1) 24VDC redundancy module, of each type used.

10. Two (2) spare filters for each filter louver with a powered fan and each air conditioner.

PART II - PRODUCTS

2.0 GENERAL CONSTRUCTION REQUIREMENTS FOR INSTRUMENT AND CONTROL CABINETS/PANELS

A. All instruments, devices and wiring shall be arranged such that everything can be installed, removed and serviced through the door. Cabinets shall be of the approximate size as shown on the Plans. Alternate arrangements of equipment within panel will be reviewed by Engineer/Owner upon recommendations (if any) by the manufacturer.

B. Wire entering the cabinets shall enter via conduits with hubs. Any panel(s) located outside of a building shall **NOT** have penetrations on the top side of the enclosure. All wiring shall be terminated on terminals located on an interior panel prior to being connected to any instrument or switch. All internal wiring shall be accomplished by the ICS prior to shipment. All wiring and terminals shall be clearly marked, and wiring schematics furnished. All wiring shall be neatly bundled, laced together and routed as required throughout the cabinet.

C. I/O signal wiring to PLC racks shall be terminated to terminal blocks/strips segregated and isolated from terminal blocks/strips of any other equipment. This requirement also applies to discrete and analog signal wiring to multiple remote instrument and control panels/cabinets.

D. Do not install proposed instrument and control devices/equipment directly to sheet metal work of the cabinet.

2.1 REQUIREMENTS FOR INSTRUMENT AND CONTROL CABINETS/PANELS

A. General:

1. The various instrument and control cabinets/panels shall be constructed to the approximate dimensions and instrument arrangement as shown on the PLANS. The Engineer/Owner will review alternate arrangements and recommendations.

2. Furnish and install where required by the PLANS.

3. Hinges and doors shall be capable of supporting weight of equipment mounted on doors.

4. Mounting channels and interior panels shall be provided in the cabinets for mounting terminals, relays, etc.

5. The cabinet shall be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located in the panel.

6. Furnish and install both isolated and non-isolated ground bars for each cabinet. Furnish and install for each ground bus:

   a. Required number of terminals for proper wiring in addition to 20 percent spare terminals for future connections

   b. Isolated Ground Bus Only: 600 volt mounting isolators.

   c. Certain microprocessor-based control equipment (PLCs, etc.) will require the connection of both distorted and undistorted (isolated) ground wires. Provide this wiring as required.

7. Submit exterior paint finish for approval by Engineer/Owner prior to procurement.

8. All painted enclosures shall have a painted white interior

9. All back panels and side panels shall be carbon steel powder coated white

B. Modular Freestanding Cabinets/Panels:

1. Type: Freestanding, modular design, completely enclosed

2. Configuration: Provide Single Bay and Double Bay as required. Use Double-Bay where possible. Each Single Bay section shall have one door, each Double-Bay section shall have two doors, unless specifically shown otherwise on the PLANS. Provide sections with rear doors where specifically shown on the PLANS.

3. Minimum Size: 2200mm x 800mm x 800mm

4. Enclosure Material: Steel

5. Framing Member Thickness: 12 gauge, minimum

6. Door/panel member Thickness: 14 gauge, minimum.

7. Rating: NEMA-12 gasketed

8. Finish: Prime and paint using manufacturer's standard process.

9. Finish Color: For Contract Bidding purposes, exterior shall be Light Ivory (RAL 1015) with textured finish and standard white interior finish. The final exterior/interior cabinet components color shall be selected by the OWNER after Contract Bid Award.

10. Interior Panel Finish Color: All interior back and side panels shall be carbon steel powder coated white.

11. Additional Requirements for each Door:

    a. Solid, Gasketed, and Hinged

    b. 3-point latching mechanism, door latch rods shall have rollers

    c. Padlocking flush handle

    d. Reinforcing bars for inner device panels

    e. Data pocket

    f. Door stop kit

    g. Thermostatically controlled exhaust fan, complete with filtered louver. Fan rated for 120V AC Connect as shown on the PLANS. Refer to the PLANS. Exception: fans and louvers are not required for rear doors.

        1) Exhaust Fans shall be mounted on upper portion of the front doors with the fans pulling air from inside of the cabinet, forcing air out.

    h. Air intake/exhaust louver. Refer to the PLANS.

    i. Electrically bonded to the frame using manufacturer's grounding device assembly and #12 AWG green insulated ground wire.

12. Comply with the requirements of the PLANS.

13. Miscellaneous Accessories:

    a. Provide each section with 7.5-inch high solid plinth base. Include solid base access panel covers.

    b. Provide 1-1/2 inches high removable heavy-duty fiberglass floor grating at the bottom of each section (above the plinth base). The floor gradient shall be no longer than the width of the door. The floor grating shall meet OSHA safety standards for personnel traffic. Wiring routed underneath grating shall be neatly laced/arranged.

1) Manufactured by Century Composite - 1.5" THICK FIBERGLASS GRATING (SQUARE MESH) or approved equal by Owner/Engineer.

c. Include all back, joining, side, hinged swing-out, etc. panels, slide-out shelves, 19" rack mounting brackets, all associated mounting hardware to facilitate a complete installation and a totally enclosed overall cabinet. Also refer to the PLANS. All panels shall be full height unless specifically shown otherwise on the PLANS.

d. Removable lifting eyes

e. Panel stabilizers and extra support brackets where conduit connects to the enclosures.

f. Cabinet manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation.

g. Provide overall master nameplate for the cabinet, as hereinafter specified, with the exception that the text height shall be 3/8 inch.

14. The cabinets shall be as manufactured by "HOFFMAN" Model Global IEC Industrial Enclosures complete with specified accessories, Rittal, or approved equal by Owner/Engineer.

C. Freestanding Cabinets/Panels:

1. Type: Freestanding, completely enclosed. Furnish and install with door(s) and interior full sized backpanel as specified hereinafter.

2. Mounting Location:

a. Outdoor / Indoor (Non-Climate Controlled):

1) Enclosure Material: Type 316 Stainless Steel

2) Rating: NEMA-4X

b. Indoor (Climate Controlled):

1) Enclosure Material: Carbon Steel

2) Rating: NEMA-12

3) Finishing:

a) For Contract Bidding purposes, exterior shall be ANSI-61 gray powder coating with textured finish and standard white interior finish. The final exterior/interior cabinet components

color shall be selected by the OWNER after Contract Bid Award.

3. Interior Panel Finish Color: All interior back and side panels shall be carbon steel powder coated white.

4. Additional Requirements for each Door:

   a. Solid, Gasketed, and Hinged

   b. Door latch handle with 3-point for cabinets

   c. Padlocking housing latch

   d. Data pocket

   e. Door stop kit

   f. Electrically bonded to the frame using manufacturer's grounding device assembly and #12 AWG green insulated ground wire

5. Panel stabilizers and extra support brackets where conduit connects to the enclosures.

6. Cabinet manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation

7. Each enclosure shall be as manufactured by Hoffman series industrial enclosures, Saginaw enclosures, or approved equal by Owner/Engineer. Complete with specified accessories.

D. Wall/Rack Mounted Cabinets/Panels:

1. Type: Wall/surface mounted, completely enclosed. Furnish and install with door and interior full sized backpanel as specified hereinafter.

2. Mounting Location:

   a. Outdoor / Indoor (Non-Climate Controlled):

      1) Enclosure Material: Type 316 Stainless Steel

      2) Rating: NEMA-4X

   b. Indoor (Climate Controlled):

      1) Enclosure Material: Carbon Steel

      2) Rating: NEMA-12

3) Finishing:

a) Exterior: ANSI-61 gray powder coating

b) Interior: Standard white

3. Interior Panel Finish Color: All interior back and side panels shall be carbon steel powder coated white.

4. Additional Requirements for each Door:

a. Solid, Gasketed, and Hinged

b. 1/4 (quarter) turn door latches

c. Door latch handle with 3-point for panels 24” and larger

d. Padlocking housing latch

e. Data pocket

f. Door stop kit

g. Electrically bonded to the frame using manufacturer’s grounding device assembly and #12 AWG green insulated ground wire

5. Panel stabilizers and extra support brackets where conduit connects to the enclosures.

6. Cabinet manufacturer’s additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation

7. Each enclosure shall be as manufactured by "Hoffman" model Concept series industrial enclosures, “Saginaw” model Enviroline enclosures, or approved equal by Owner/Engineer. Complete with specified accessories.

E. Corrosive Area Wall/Rack Mounted Cabinets/Panels:

1. Type: wall/surface mounted, completely enclosed. Furnish and install with door and interior full sized backpanel as specified hereinafter.

2. Enclosure Material: Polycarbonate

3. Rating: NEMA-4X gasketed

4. Additional Requirements for each Door:

a. Solid, Gasketed, and Hinged

b. Lockable hasp

c. Data pocket

d. Door stop kit

e. Door stiffening kit

5. Panel stabilizers and extra support brackets where conduit connects to the enclosures.

6. Cabinet manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation

7. Enclosure shall be as manufactured by Saginaw, Allied Moulded, Integra, or approved equal by Owner/Engineer. Complete with specified accessories.

2.2 INSTRUMENT AND CONTROL CABINETS EQUIPMENT

A. Overcurrent Protection

1. General: Individually protect each device as shown on the PLANS. Furnish and install protection using the devices shown on the PLANS and as specified hereinafter.

2. Size each circuit breaker to provide proper protection for instrument and/or control device per NEC. Tag each circuit breaker similar to the terminal blocks, as defined as specified hereinafter.

   a. 120 Volts A.C. Overcurrent Protection:

      1) Proposed Circuit breakers shall be:

         a) UL-489 Listed

         b) DIN-rail mountable

         c) Visible trip indicator

         d) IP20 finger-safe guards

         e) Trip Curve "C"

         f) Manufactured by Allen-Bradley Series 1489-M, Siemens 5SJ4..-.HG41, or approved equal.

   b. 24 Volts D.C. Overcurrent Protection:

1) Proposed Circuit breakers shall be:

   a) UL-489 Listed

   b) DIN-rail mountable

   c) Visible trip indicator

   d) IP20 finger-safe guards

   e) Trip Curve "C"

   f) Manufactured by Allen-Bradley Series 1489-M, Siemens 5SJ4..-.HG41, or approved equal by Owner/Engineer.

B. 24 VDC Power Supplies & Redundancy/Switchover Module

1. Power supplies shall be installed and wired as shown on the PLANS in accordance with the following specifications.

2. 24 VDC Power Supplies:

   a. The power supply shall operate from 120 VAC input power and shall provide direct current output current of a minimum 5 amperes at 24 VDC at 60 degrees Celsius. The power supply output voltage shall be adjustable from 22.5 to 28.5 VDC by screwdriver operated adjustment. The power supply shall be furnished with a maintained action alarm contact that changes state upon power supply/switchover module failure. Power Supply output load regulation shall be 2 percent maximum from zero to full load. Power Supply output ripple voltage shall not exceed 50 millivolts measured peak-to-peak at full load. Each power supply shall have integral output current limiting and over voltage protection. Each power supply shall have a fully enclosing case and be DIN rail mountable. The power supply shall also have a 5-year warranty and field selectable switch to select single or parallel operation.

   b. Power supply shall be manufactured by Sola/Hevi-Duty, Model SDN-P series with specified accessories, or approved equal by Owner/Engineer.

      1) Contractor shall preform a load calculation and supply documentation confirming load. Power supplies shall be sized for total load plus twenty-five percent for future.

3. 24 VDC Power Supply Redundancy/Switchover Module:

   a. The module shall provide the capability to immediately and automatically transfer load from the primary to the backup (secondary) power supply unit, as also shown on the PLANS. The module shall operate from two (2) 24VDC input power sources and

shall have a nominal current rating of a minimum 20 Ampere at 24VDC at 60 degrees Celsius. The redundancy module shall be furnished with a maintained action alarm contact that changes state upon power supply/switchover module failure. The module shall also have a 5-year warranty.

b. The module shall be manufactured by the same manufacturer as the power supplies and manufactured by Sola/Hevi-Duty, Model SDN Redundancy (RED) Module or approved equal by Owner/Engineer.

C. Control Relays:

1. Control relays shall be provided as required by the schematic diagrams. Refer to the PLANS. Mount control relays on the DIN-rail on the back panels (device panels/subpanels) located inside the cabinets. All control relays shall be Type I relays unless specifically noted otherwise on the PLANS or as specified hereinafter. The minimum requirements for the different types of relays are as described below:

   a. Type I Control Relays:

      1) Type: 300 volt "Ice-Cube" type

      2) Rated: Pilot-Duty C300 rated

      3) Coil Voltage: 120 volts A.C.

      4) Contact Rating: 10A at 120 volts A.C.

      5) Number and Configuration of Contacts: three Form-C Contacts (3PDT)

      6) Position Indication: Integral LED pilot light

      7) Manual Operator: Integral to relay

      8) Mounting: DIN rail mountable socket

      9) Accessories: Socket

      10) Manufacturer: "Allen-Bradley" Bulletin 700-HA33A1-3-4, complete with 700-HN126 socket or approved equal by Owner/Engineer.

   b. Type II Control Relays: Relays shall be used only where specifically shown on the PLANS that the relay coil is in a 120VAC circuit. Relays shall be 300 volts "Ice-Cube" type with 120-volt AC (nominal voltage) coils. Minimum contact rating shall be 15A at 120 volts AC. Relays shall be configured with three (3) Form-C contacts (3PDT). Relay shall be equipped with LED indicator light and push-to-test button. Furnish relay complete with socket. Relay socket shall be

DIN-rail mountable. Relays shall be "Allen-Bradley", 700-HB33A1-3-4 complete with relay socket base 700-HN154 or approved equal by Owner/Engineer.

c. Type III Control Relays: Relays shall be used only where specifically shown on the PLANS that the relay coil is in a 24VDC circuit. Relays shall be 300 volts "Ice-Cube" type with 24-volt DC (nominal voltage) coils. Minimum contact rating shall be 10A at 120 volts AC. Relays shall be configured with four (4) Form-C contacts (4PDT). Relay shall be equipped with LED indicator light and push-to-test button. Furnish relay complete with socket. Relay socket shall be DIN-rail mountable. Relays shall be "Allen-Bradley", 700-HF34Z24-3-4 complete with relay socket base 700-HN139 and or approved equal by Owner/Engineer.

D. Timing Relays:

1. Timing relays shall be provided as required by the schematic diagrams. Refer to the PLANS. Solid state, multi-time, and multi-function type relay. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes: On Delay, Off Delay, One Shot, Repeat Cycle, and Interval. Minimum relay contact rating shall be 10 amps, continuous, at 120 VAC. Coils shall be 120 VAC. Timing relays shall be Square D Class 9050 model No. JCK70 complete with Type NR61 socket, or approved equal by Owner/Engineer. Mount control relays on the DIN-Rail located inside the cabinets.

E. Elapsed Time Meters:

1. Elapsed time meters shall be provided as required by the schematic diagrams. Refer to the PLANS.

2. Totally sealed black polymer round, flush panel mounted enclosure with mounting clip.

3. Non-resettable quartz electronic clock timing.

4. Operating voltage: 90-264 volts AC.

5. Temperature range: -40 degrees C to +85 degrees C

6. Reading at least to 99999.9 hours and at least to nearest one-tenth of an hour.

7. White digits on black background

8. U. L. recognized

9. Manufacturer: Trumeter 722-0003 complete with 5003-008 NEMA 4X gasket or approved equal by Owner/Engineer.

F. Pushbuttons, Selector Switches and Pilot Lights:

1. Indicating lights shall be NEMA Style, full size 30-millimeter (30mm), Universal Light Emitted Diode (LED), NEMA 4/4X/13 corrosion-resistant/watertight/oiltight, full voltage, push to test type, rated at 12-130V AC/DC, with legend plate marked as shown on the PLANS. Lens color shall be as shown on the PLANS. Refer to PLANS control schematics and details for the exact color requirements. Pilot lights shall be as manufactured by Allen-Bradley 800H. Miniature size pilot lights will **NOT** be accepted.

    a. Stackable Sealed Switch Blocks shall be utilized for use in a Class I, Div. 2 hazardous location or as shown on Plans. Shall be manufactured by Allen-Bradley 800R.

2. Pushbuttons and Selector Switches shall be Heavy duty NEMA 4/4X/13, corrosion-resistant/watertight/oiltight, NEMA Style full size 30-millimeter (30mm), pushbuttons and selector switches as required by the PLANS. The number of contact blocks shall be as required by the PLANS. The selector switches and pushbutton contacts shall be rated 10-amperes minimum at 120 volts AC. The selector switches shall be furnished with Black Knob Lever Operators. The color of the pushbutton operator shall be as shown on the PLANS, Black otherwise. Selector switches and pushbutton operators and contact blocks shall be Allen-Bradley 800H. Miniature size stations will **NOT** be accepted.

    a. Stackable Sealed Switch Blocks shall be utilized for use in a Class I, Div. 2 hazardous location or as shown on Plans. Shall be manufactured by Allen-Bradley 800R.

3. Mushroom Head Push Buttons: NEMA style, heavy duty, NEMA 4/4X/13 corrosion-resistant/watertight/oiltight mushroom head pushbutton with the number of contact blocks required by the schematic diagrams. Mushroom head pushbutton contacts shall be rated 10 amps at 120VAC. The contact blocks shall be provided with finger-safe guards (guards on contacts). The mushroom head pushbuttons shall be the two-position "Push-Pull" type with RED mushroom head button. The mushroom head pushbuttons shall be as manufactured by Allen-Bradley 800H. Miniature size stations will **NOT** be accepted. Each button shall be provided with a hinged polycarbonate corrosion resistant locking cover. **Cover shall be capable of closing without actuating the push button.** Cover shall be C3 Controls Model LOAFC or approved equal by Owner/Engineer.

    a. Stackable Sealed Switch Blocks shall be utilized for use in a Class I, Div. 2 hazardous location or as shown on Plans. Shall be manufactured by Allen-Bradley 800R.

4. Legend Plates for Control Panel: Provide legend plates for each control station, and each pilot device installed in a control panel per details

shown on the drawings. Additionally, the legend plates shall be the Manufacturer's standard with lettering indicated on the Plans.

G. Convenience Receptacle:

1. Furnish and install where required by the PLANS. Additional receptacle assembly features are as follows:

   a. Specification grade

   b. Duplex, 3-wire, polarized grounding type, rated 20A, 125-volt, 60 Hertz

   c. Color:

      1) Utility Power / Non-Uninterrupted Power Supply (UPS) Power: Ivory

      2) Uninterrupted Power Supply (UPS) Power: Red

   d. Manufacturer: Hubbell No. HBL5362I or HBL5362R, Bryant, Pass and Seymour, or approved equal by Owner/Engineer.

   e. Coverplate: 304 brushed stainless steel, as manufactured by Hubbell, Killark, or approved equal by Owner/Engineer.

   f. Install in NEMA-1 enclosure inside of the control panel.

H. Lighting Fixture:

1. Furnish and install where required by the PLANS. Additional light fixture features are as follows:

   a. Type: LED

   b. Voltage: 120 volts A.C

   c. Length: 24 inches

   d. Lumens per fixture: 900 lumens

   e. Motion sensors shall not be accepted.

   f. Convenience receptacle outlet shall not be accepted

   g. Manufacturer: Saginaw SCE-LF24NO, Hoffman, or approved equal by Owner/Engineer.

I. Panel Intrusion Switch:

1. Furnish and install where required by the PLANS.

2. Type: Remote mount door switch

3. UL Recognized Component

4. Manufacturer: Saginaw SCE-LSA, Hoffman, or approved equal by Owner/Engineer.

J. Digital Indicators/Displays

1. Furnish and install where required by the PLANS.

2. Refer to additional Specification Sections

K. Surge Protectors:

1. 120VAC Surge Protector:

   a. Furnish and install where required by the PLANS

   b. Visual fault indicator with remote contact

   c. 40kA surge current rating

   d. DIN-rail mountable

   e. UL1449

   f. Manufacturer: Citel DS42S-120 or approved equal by Owner/Engineer.

2. Analog Signal Surge Protector:

   a. Furnish and install where required by the PLANS

   b. Visual fault indicator

   c. 20kA max discharge current

   d. 5kA nominal discharge current

   e. DIN-rail mountable

   f. UL497B

   g. Manufacturer: Citel DLAS-24D3 or approved equal by Owner/Engineer.

L. Single Input, Single Output Instrument Loop Current Isolators (I/I Converters):

1. The loop current isolators shall be utilized when wiring three (3) or more field devices in series.

2. The loop current isolators shall be designed for one 4-20mA input and one 4-20 mA isolated output signal and equipped with a built-in load trimmer.

3. The loop isolator shall be capable of driving a 4-20mA signal into a maximum load of 1000 Ohms on the output channel.

4. The loop current isolator shall be powered from an external 120VAC supply as also shown on the PLANS.

5. The output loop current accuracy shall be +/- 0.1% of full span. The loop isolator shall be equipped with RFI/EMI protection such that less than +/- 0.1% of span error is incurred when tested against a reference signal of 30 volts per meter over the frequency range of 20 to 1000 MHz, inclusive.

6. Each loop isolator shall be equipped with the field selectable transmitter excitation option which allows the isolator to supply 24VDC power to a 2-wire instrument connected to the isolator input. For those instruments which do not source DC power to the isolator input loop, wire the isolator so that it supplies 24VDC power to the input loop. For those instruments which source DC power to the isolator input loop, wire the isolator so that it does not supply DC power to the input loop.

7. The loop isolator shall be of the high-density type with corrosion resistant metal housing. The isolators shall be mounted on a rail (DIN-rail mounting) in the control panel where shown on the PLANS. Each loop isolator shall be tagged by loop number and loop process identification, as also shown on the PLANS.

8. The loop current isolators shall be as manufactured by MOORE Industries Model ECT-DIN with TX and RF options, or approved equal by Owner/Engineer.

M. Terminal Blocks:

1. General:

   a. All terminal blocks shall be provided with manufacturer's standard snap-in marker card and holder as manufactured by Allen-Bradley Bulletin No. 1492-SMN81, Phoenix Contact, or approved equal. Provide manufacturer's standard typed adhesive terminal block tag for each terminal block.

   b. Provide manufacturer's standard insulating jumpers, DIN rail, barriers, end anchors, group markers, etc., and all related mounting hardware as required for a complete and functional installation. Coordinate models of terminal block accessories such as end anchors, jumpers, DIN rail, etc., with the terminal blocks as specified hereinafter for a complete and functional installation.

   c. All terminal blocks shall be Type I terminal blocks unless specifically

noted otherwise on the PLANS or as specified hereinafter. All terminal blocks shall be sized appropriately for loads.

2. Type I Terminal Blocks:

   a. Rating: 600 volts A.C./D.C., 30A

   b. Type: Single Layer

   c. Wire Range: No. 30 through No. 12 AWG

   d. Material: Nylon or polypropylene

   e. Quantity per Foot: 50

   f. Color: As specified hereinafter.

   g. Manufacturer: Phoenix Contact UT-4, Allen-Bradley Bulletin 1492-HM1, or approved equal by Owner/Engineer.

3. Type II Terminal Blocks:

   a. Rating: 600 volts A.C./D.C., 55A

   b. Type: Single Layer

   c. Wire Range: No. 22 through No. 8 AWG

   d. Material: Nylon or polypropylene

   e. Quantity per Foot: 37

   f. Color: As specified hereinafter.

   g. Manufacturer: Phoenix Contact UT-6, Allen-Bradley Bulletin 1492-HM3, or approved equal by Owner/Engineer.

4. Type III Terminal Blocks:

   a. Rating: 100-300 volts A.C., 15A

   b. Type: Single Layer, fused terminal blocks

   c. Wire Range: No. 30 through No. 12 AWG

   d. Material: Nylon or polypropylene

   e. Quantity per Foot: 33

   f. Fuse: Bussman ¼ inch x 1-1/4 inch.

   g. Miscellaneous: Provide with Neon blown fuse indicator

h. Manufacturer: Allen-Bradley Bulletin 1492-H4, Phoenix Contact, or approved equal by Owner/Engineer.

5. Type IV Terminal Blocks:

   a. Rating: 10-57 volts A.C./D.C., 15A

   b. Type: Single Layer, fused terminal blocks

   c. Wire Range: No. 30 through No. 12 AWG

   d. Material: Nylon or polypropylene

   e. Quantity per Foot: 33

   f. Fuse: Bussman ¼ inch x 1-1/4 inch.

   g. Miscellaneous: Provide with LED blown fuse indicator

   h. Manufacturer: Allen-Bradley Bulletin 1492-H5, Phoenix Contact, or approved equal by Owner/Engineer.

6. The color of each Terminal Blocks shall be based on function and type of the wiring terminated to the block. The color coding of the terminal blocks shall be as follows:

FUNCTION:	**COLOR CODE:**
All Terminal Blocks excepts for below	GREY
Intrinsically Safe	BLACK
Isolated Ground Terminal Blocks (Feed Through Type)	GREEN
Non-Isolated Ground Terminal Blocks (DIN-Rail Grounded Type)	GREEN/YELLOW

2.3 INSTRUMENT AND CONTROL CABINETS WIRING

A. General Wiring: All control wiring shall be a **minimum** extra flexible 41-strand, **#14 AWG**, copper conductor, 600V insulation, **SIS wire** manufactured by General Cable Company, The Okonite Company, or approved equal by Owner/Engineer. All control wiring shall be sized and shall adhere to the most recent approved version of the National Electrical Code (NEC). Color coding shall be as follows:

FUNCTION: **COLOR CODE:**

120VAC power wiring	BLACK = HOT WHITE = NEUTRAL
120VAC control/status signal wiring. This does not apply to control/status signal wiring that are scheduled for interface with Programmable Logic Controller (PLC) and Annunciator	RED
Control/status signal wiring to Programmable Logic Controller (PLC) - Discrete Input Modules (as shown on the PLANS)	VIOLET
Control/status signal wiring from Programmable Logic Controllers (PLC's) – Discrete Output Modules (DO's as shown on the PLANS)	PINK
Annunciator	YELLOW
Ground Wires	GREEN
24VDC power & control wiring	BLUE = POSITIVE (+) BROWN = NEGATIVE (-)

B. 4-20 Milliamp Signal wiring: Twisted pair, **#16 AWG** stranded copper conductors with PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum-mylar shield, an outer PVC jacket, and 300V insulation. Dekoron Division Cat. No. 1852, Samuel Moore and Company, or approved equal by Owner/Engineer. Color of the twisted pair shielded cable jacket shall be BLACK. The color of the **positive (+)** conductors shall be **BLACK** and **negative (-)** conductors shall be **WHITE**.

C. Resistance Temperature Detector "RTD" Signal wiring: Twisted triad, #16 AWG stranded copper conductors with PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum-mylar shield and an outer PVC jacket. Samuel Moore and Company, Dekoron Division, Cat. No. 1862 or approved equal by Owner/Engineer. Color of the twisted pair shielded cable jacket shall be BLACK. Individual Conductor Insulation Color shall be as follows: **Positive (+)** is **Black**, **Negative (-)** is **White**, **Sense (S)** is **Red**.

D. Fiber Optic Cable and Ethernet Data Communication Cable:

1. Refer to Specification Section 17620 Fiber Optic & Ethernet Communication Equipment.

2.4 INSTRUMENT AND CONTROL CABINETS THERMAL MANAGING EQUIPMENT

A. **General**:

1. Contractor shall preform a heat load calculation for all instrument and control cabinets/panels. The contractor shall supply documentation confirming heat load within each cabinet and provide an accurate heating and/or cooling system to maintain the required internal temperature.

B. Ventilation Cooling Thermostats:

1. Furnish and install where required by the PLANS.
2. Measurement Range: Thermostat: 32-140 degrees Fahrenheit, (0-60 degrees Celsius)
3. Internal Temperature Range: 40-90 degrees Fahrenheit
4. Contact Ratings: Contact: 10A at 250VAC
5. Mounting: DIN-rail mountable
6. UL Recognized Component
7. Manufacturer: Finder 7T8100002303 Ventilation Cooling Thermostat or approved equal by Owner/Engineer.

C. Ventilation Cooling Fans & Louvers:

1. Furnish and install where required by the PLANS.
2. Volume Air Flow Rate (CFM): Provide as required per heat load calculation
3. Internal Temperature Range: 40-90 degrees Fahrenheit
4. Voltage Rating: 110-120VAC
5. NEMA Rating: Shall not be of a lesser rating than enclosure and shall not derate the enclosure.
6. UL Recognized Component
7. Mounting:
    a. Exhaust Fan shall be mounted on the upper portion of enclosure with the fan pulling air from inside of the enclosure, forcing air out.
    b. Exhaust Fan shall not block access to any wireways or equipment.

8. Manufacturer: Saginaw, Hoffman, or approved equal by Owner/Engineer.

D. Air Conditioners:

1. Furnish and install where required by the PLANS.
2. BTU/hr Rating: Provide as required per heat load calculation
3. Internal Temperature Range: 40-90 degrees Fahrenheit
4. Voltage Rating: 110-120VAC
5. Mounting: Side mount
6. NEMA Rating: Shall not be of a lesser rating than enclosure and shall not derate the enclosure.
7. Warranty: Minimum five-years
8. UL Recognized Component
9. Manufacturer: Thermal Edge or approved equal by Owner/Engineer.

E. Anti-condensation Heater with Thermostat and Fan:

1. Furnish and install where required by the PLANS.
2. Housing: Brushed Aluminum
3. Thermostat Range: 0-100 degrees Fahrenheit, (-18-38 degrees Celsius)
4. Mounting: Panel Mount
5. UL Recognized Component
6. Internal Temperature Range: 40-90 degrees Fahrenheit
7. Wattage: Provide as required per heat load calculation
    a. Minimum 200W
8. Integral Fan
9. Manufacturer: Saginaw SCE-HF Series, Hoffman DAH Series, or approved equal by Owner/Engineer.

F. Panel Temperature Transmitter:

1. Furnish and install where required by the PLANS.
2. Qualifications:

a. Manufacturer shall be proven in the fabrication of the temperature transmitters and RTD's. Manufacturer may be requested to furnish customer data base to substantiate proven manufacturer –minimum of five years in business, customers' company name, name of contact person and telephone number.

b. The temperature transmitter shall be furnished pre-calibrated and have trimmer pots to provide for a zero and span adjustment.

3. Performance:

a. Range: 0-200 degrees F

b. Accuracy: 0.1% full scale

c. Outputs: 4-20 mA

d. Supply Voltage: 24 VDC

4. Functions/Features/Options:

a. Furnished with matched RTD

b. 4-20 mA Output

5. Acceptable manufacturers or approved equal by Owner/Engineer.

a. The temperature transmitter shall provide accurate and reproducible conversions of RTD resistance signals to 2 wire 4-20mA outputs as manufactured by Devar Inc., Model SM812-EC-0012-RTD with Sensor 515315-0003.

2.5 INSTRUMENT AND CONTROL CABINETS UNINTERRUPTIBLE POWER SUPPLY

A. Furnish and install an UPS inside the control panel enclosure where shown on the PLANS. Each UPS shall be as follows:

1. General:

a. Apparent Power: Provide for the maximum connected load and as shown on the PLANS.

b. Run Time (without input power): Minimum duration of forty-five (45) minutes in the event of permanent power loss to the UPS AC input with the UPS serving all connected load at full load.

c. Contractor shall preform a load calculation and supply documentation confirming load.

d. Provide battery extension cabinet where required to obtain a minimum duration runtime of forty-five (45) minutes for the connected load in the event of a power loss and where shown on the PLANS.

e. Input/Output Voltages: 120 volts AC, 60 Hz.

f. Connections: Minimum of four 120VAC, (4) 15A output receptacles.

g. Warranty: Two (2) year manufacturer's warranty.

h. Provide additional features as shown on the PLANS.

2. Type 1:

a. Minimal KVA rating: 3.0KVA

b. External Maintenance Bypass Switch:

1) The UPS shall be provided with a manufacturer's standard external maintenance bypass switch. The external maintenance bypass switch shall be sized such to carry the full load current of the UPS inclusive of inrush current, at minimum. Also refer to the requirements shown on the PLANS. The maintenance bypass switch shall be installed in such a manner that the selector switch is accessible from the front of the control cabinet. Provide any additional accessories necessary to facilitate the installation of the maintenance bypass switch.

c. The UPS shall consist of a relay I/O module which provides relay output contacts. At minimum, the card shall consist of a dry contact indicating:

1) UPS On

2) UPS Low Voltage

3) UPS Fail.

Alarm contacts shall be wired as a single discrete input into the programmable logic controller to indicate a UPS common trouble/fail alarm. Also refer to PLANS for wiring to the UPS relay I/O module.

d. The UPS shall be provided with all necessary interconnecting cables, connectors, Windows compatible configuration software (if necessary), for a complete and functional installation.

e. Mount UPS within the control cabinet, without obstructing access to components within cabinet. Install UPS in accordance to manufacturer's requirements and recommendations, including proper UPS power termination, ventilation, and cooling.

f. Provide for the mounting configuration as shown on the PLANS.

g. Manufacturer: Eaton Model 9PX Series UPS with external maintenance bypass switch Eaton HotSwap MBP Model EHBPL****R-PDU1U (where **** is based on UPS rating), and Relay Interface Card Eaton Model No. RELAY-MS, or approved equal by Owner/Engineer.

3. Type 2:

a. Minimal KVA rating: 1.5KVA

b. Automatic Maintenance Bypass:

1) The UPS shall be wired to a relay such that it allows for automatic bypass in the event of a UPS failure or during maintenance. One relay contact shall be wired as a discrete input into the programmable logic controller to indicate UPS in maintenance/failure.

c. The UPS shall be provided with all necessary interconnecting cables, connectors, Windows compatible configuration software (if necessary), for a complete and functional installation.

d. Mount UPS within the control cabinet, without obstructing access to components within cabinet. Install UPS in accordance to manufacturer's requirements and recommendations, including proper UPS power termination, ventilation, and cooling.

e. Provide for the mounting configuration as shown on the PLANS.

f. Manufacturer: Eaton Model 9PX Series UPS, APC Smart-UPS or approved equal by Owner/Engineer.

2.6 PROGRAMMABLE LOGIC CONTROLLERS "PLCS" AND ASSOCIATED EQUIPMENT

A. Refer to Specification Section 17600 PLCs & OIUs Equipment.

2.7 FIBER OPTIC CABLES, CORDS, MODEMS AND ASSOCIATED EQUIPMENT

A. Refer to additional Specification Sections

2.8 INSTRUMENT AND CONTROL DEVICES IDENTIFICATION

A. Instrument and Control Devices Identification

1. General:

   a. The device designations shall agree with those shown on the PLANS.

   b. Each device shall be provided with permanent type identifying nameplate.

   c. Devices which penetrate the door shall be provided with two nameplates, one located on face of the door and one located on the rear of the door.

   d. Panel identifications shall **NOT** be mounted on wireway covers.

2. Devices located on the face of the door of the instrument control cabinets/panels:

   a. Nameplates:

      1) Type: 2-ply thickness, co-extruded impact acrylic

      2) Color: White text on a black background, unless shown otherwise on the PLANS.

      3) Lettering: 1/4-inch height minimum unless shown otherwise on the PLANS, engraved.

      4) Accessories: Provide holes for mechanical fastening.

   b. Shall be secured with two Type 316-Stainless Steel screws.

3. Devices located on the rear of door or inside of instrument control cabinets/panels:

   a. Nameplates:

      1) Type: Electronically printed laminated tape, typed with indelible marking process. Handwritten shall not be accepted.

      2) Color: Black text on a white background, unless shown otherwise on the PLANS.

      3) Lettering: 1/8-inch height minimum unless shown otherwise on the PLANS

   b. Location: All nameplates shall be easily visible after components and wiring have been installed.

4. Field mounted control and instrument devices:

   a. Devices shall be provided with two nameplates, one laminated located on the face or top of the instrument and one suspended on the instrument.

b. Laminated Tape Nameplates:

1) Type: Electronically printed laminated tape, typed with indelible marking process. Handwritten shall not be accepted.

2) Color: Black text on a white background, unless shown otherwise on the PLANS.

3) Lettering: 1/4-inch height minimum unless shown otherwise on the PLANS

c. Suspended Nameplates:

1) Type: Stainless-steel, unless shown otherwise on the PLANS.

2) Lettering: 1/4-inch height minimum unless shown otherwise on the PLANS, engraved.

3) Securely suspend nameplates from each instrument/control device by a flexible stainless-steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).

B. Wire Tag:

1. Rating: Flame-Retardant,

2. Style: Heavy-Duty Industrial Grade

3. Type: Heat Shrinkable type.

4. Character Height: 1/8 inch.

5. Maximum Length: 2 inches.

6. Text Type: Typed with indelible marking process. Handwritten shall **NOT** be accepted.

7. Color: Yellow and/or White

a. Mark all proposed wiring (power, control, instrument, alarm, data, etc.) at each end of each wire. All control wire tags shall be **YELLOW** in color. Panel lighting, convenience receptacle circuits, and 120 volts AC power circuits to devices/instruments/PLC power supplies shall be **WHITE**.

8. Manufacturer: "Raychem type Heavy-Duty Industrial Grade ShrinkMark Heat-Shrinkable Marking Sleeves" or approved equal by Owner/Engineer. Utilize "Raychem" Portable-Marking-System" complete with wire tag cartridges or approved equal.

9. Do **NOT** Heat Shrink Wire Tags.

C. Wire Tagging Methodology:

1. Refer to Specification Section 16205

PART III - EXECUTION

3.0 SHIPMENT AND STORAGE

A. Delivery: Enclose cabinets and subassemblies in heavy polyethylene envelopes to protect them from dust and moisture. Place corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

B. Storage: All materials and equipment shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment, provided by the contractor; OWNER shall not be responsible for storage. The Main Instrument Controls, control equipment, and the field control and instrument/monitoring panels shall not be moved from climate-controlled storage room to the project site until the renovation of the applicable PLC group is to occur, per owner approval.

C. Handling of cabinets shall be accomplished with extreme care, especially after removal from shipping containers.

3.1 PANEL ASSEMBLY

A. Routing and Termination of Wiring:

1. Terminate all incoming wiring and inter-cabinet wiring to terminal blocks.

2. Provide separate terminal blocks for power wiring, from control/discrete signal wiring, and from analog/instrument wiring. All tags must be typed and neatly attached to the marking surface. Identify each strip/string of terminal blocks with Black on White laminated tape mounted on a group marker. Laminated tape shall **NOT** be applied to wireway covers.

3. A physical barrier/separator shall be provided to isolate control signal wiring from voltages above 120V line-to-neutral. The barrier/separator shall be made of a non-conductive material.

4. Route power supply wiring or wiring common to more than one device or instrument individually from the terminal strips to each device. Do not loop wiring between devices.

5. Insulated jumper bars for terminal blocks may be utilized where available. However, multiple insulated jumper bars shall **NOT** be connected in series.

6. Plastic Wireway: Size as required. Also refer to the PLANS. Provide narrow finger, white color unless specified otherwise. Provide as manufactured by Panduit or approved equal by Owner/Engineer.

7. The spacing between wireways, where Din-Rail is mounted, shall have a minimum six (6) inches between the wireways.

8. On control panels with a PLC backplane/rack that are ten (10) slots or more, utilize at a minimum 4"x4" wireway that shall be mounted horizontally below the PLC.

9. Flexible Spiral Wrapping: Size as required. Provide as manufactured by HellermannTyton or approved equal by Owner/Engineer.

10. Route wiring to equipment on doors (if applicable) so that the doors can be opened to the fullest extent of travel without stressing the wiring. Attach a stud-weld on enclosure door and side of enclosure to secure wiring bundles. Adhesive Cable Tie (sticky-backs) can be utilized where wires are stationary. Adhesive Cable Tie (sticky-backs) shall be mounted with screws to secure in place; screws shall not derate the enclosure.

11. Terminate shield wire of each shielded cable to a terminal point (block) on the terminal strip (i.e., treat as current carrying conductor). Do **NOT** terminate more than one shield wire to a single terminal block (point). i.e., each twisted pair shielded cable should have three termination points independent/isolated from termination points of neighboring cables. Extend #14 AWG insulated green ground wire from each shielded cable shield termination terminal point to the main ground bar of the cabinet (shield/drain wire ground) or, if it exists, isolated main ground bar of the cabinet. A terminal strip with multiple isolated terminal points may utilize a terminal block jumper to connect shielded wire terminal blocks then extend only one #14 AWG wire to ground bar.

12. Terminal point on a device, relay, instrument, etc. will **NOT** be considered the same as terminal located on a terminal block. Terminal blocks, terminal symbols, etc. shown on the drawings are in reference to terminal blocks, terminals, etc. independent of any terminal strip and/or termination point furnished with/on the device, relay, instrument, etc.

13. Spare wires shall be tagged, capped, and left coiled inside the cabinet.

14. The spare terminal blocks/strip shall be identified as future use - spare.

3.2 INSTALLATION

A. Cabinets shall be installed in the locations shown on the PLANS.

B. All wiring shall be connected as shown on PLANS and all systems shall be thoroughly checked out.

C. Install all equipment in accordance with the PLANS and instructions furnished by the manufacturer.

D. Inspect each new instrument, control component, etc., before installation. Replace deficient items.

E. Special and additional installation requirements associated with fiber optic communication system:

1. The fiber cables entering each cabinet shall be coiled, allowing at least 8-feet of additional cable. The fiber bend radius upon entry and coiling must not be less than the minimum required for the cable.

3.3 INSTALLATION REPORT

A. After installation, the manufacturer's representatives shall inspect the installation and prepare a report or reports to include the following:

1. A list of all deficiencies found.

2. Recommend corrective action for all facilities.

3. Certification that the item or system is properly installed, except as noted.

3.4 FIELD CALIBRATION AND TESTING

A. Calibrate proposed instruments/devices and prepare calibration reports. All calibration shall be performed by factory-trained technical personnel. Calibration shall be witnessed by Owner's Personnel and/or Engineer.

B. The complete system shall be tested by experienced factory-trained technical personnel. All system tests shall be witnessed by Owner's Personnel and/or Engineer.

C. Perform the following tests using simulated inputs:

1. Check the overall system and each subsystem to see that they function as specified based on simulated inputs at each sensor and at each set of field contacts monitored. This check to include the testing of all automatic functions, sounding of alarms, shutdowns, etc.

2. Check the overall accuracy of each new and modified instrument loop to ensure that it is within acceptable tolerance.

D. If defects are found under simulated conditions, make corrections and retest.

E. After start-up, test the complete system under actual conditions to determine that all specified functions can be performed.

F. After completion of start-up testing, submit a System Test Report. This report to include:

1. Certification that the system is operating correctly and within tolerances.

2. Listing of calculated tolerances for each new and modified instrument loop.

G. This is in addition to the testing requirements defined in Section 17100 of the Contract Specifications. Refer to the additional testing requirements defined in Section 17100 of the Contract Specifications.

3.5 ON-SITE OPERATIONS AND MAINTENANCE TRAINING

A. Start-up Training: Provide required instruction to the Owner's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for no less than **TWO (2) SESSIONS** for the purpose of instructing the Owner's personnel in the correct operating and maintenance procedures for all the instrument and hard-wired control system components and the entire Instrumentation and Control System, and Communications System including the various instrument and control system cabinets/panels installed in this project. This is in addition to the training requirements defined in Section 17100 of the Contract Specifications. The date of this school shall be scheduled with the Owner. Also, refer to the additional training requirements defined in Section 17100 of the Contract Specifications.

3.6 MEASUREMENT AND PAYMENT

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

3.7 WARRANTY

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents.

B. Warrant equipment free of defects in material and workmanship for 2-years; cover parts and labor. Manufacturer's warranty shall be issued in the Owner's name.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Provide all labor, materials, and equipment to design, furnish, install, calibrate, test, adjust, and place in operation all instrumentation as specified herein and as shown on the Contract Documents.

B. Instrument Type Code:

1. An Instrument Type Code identifies each instrument and consists of an alphabetical character(s) followed by three numeral characters.

    a. Example Instrument Type Code: "A123".

2. The Type Code serves as a means to reference each instrument in the specifications.

1.02 RELATED REQUIREMENTS

A. Refer to Section 17100

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

C. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.03 SUBMITTALS

A. Submit the following in accordance with the Section 01330 and 01730 of the Specifications and in accordance with Section 17100 of the Specifications:

1. Shop Drawings and product data.

2. Submit wiring schematics for all equipment.

3. Submit listing of all field instruments tag numbers for verification by OWNER.

4. Test Reports: Completed and certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.

    a. Include factory calibration for each instrument with stated accuracy.

5. Operation and maintenance manuals.

    a. Include all completed and certified test reports in manuals.

        1) Refer to specifications herein for transmitter ambient and process fluid temperature ranges to be used for basis of accuracy analysis.

6. Submit detailed listing of training class curriculum including, as a minimum, the following at least four (4) months prior to class:

    a. Specific topics for each instrument, including but not limited to, general troubleshooting, calibration, wiring, and general set-up/configuration.

    b. Anticipated duration of class for each instrument type.

    c. Names of instructor(s) for each specific instrument.

    d. Refer to instrument by Instrument Type Code as listed in this specification section where applicable.

1.04 QUALITY ASSURANCE

A. Standardization: All equipment of the same Instrument Type Code to be the product of a single manufacturer.

B. Examine the complete set of Contact Documents and verify that the instruments are compatible with the installed conditions including:

    1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

    2. Physical conditions:

        a. Installation and mounting requirements.

        b. Location within the process.

        c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the ENGINEER if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Material Compatibility:

    1. Material selections of instrument components noted in this section provide a basis for the minimum material compatibility requirements.

2. Instrument component material selections shall be subject to additional restrictions and compliance with recommendations of instrument manufacturers for the intended service.

3. Provide instrument component materials in compliance with specific process fluid temperature, pressure, chemical compatibility, and other process fluid parameters.

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Endress & Hauser

B. Foxboro

C. Rosemount

D. Dwyer

E. No Approved "Or Equals"

2.02 MATERIALS/CONSTRUCTION

A. P100 Series General Requirements:
   1. The Pressure Indicator/Transmitter shall have the following features:
      a. Signal: Two-wire 4-20mAdc (loop powered) proportional and linear to Pressure with HART communication protocol.
         1) Alarm: Configure the unit fault/alarm at 3.4 mAdc output signal.
      b. Accuracy:
         1) Spans greater than or equal to 10% of Upper Range Limit (URL): 0.06 percent of span.
         2) All Other: 0.025 + 0.0035 (URL/Span) percent of span.
      c. Ambient Temperature Range: -40°F to + 175°F.
      d. Process Temperature Range: -50°F to +250°F.
      e. DC Loop Supply Voltage Range: 12 to 42 VDC.
      f. Signal Output Load Range: 200 to 1,450 ohms.
      g. Transmitter Total Error: 0.1 percent (RMS), at a reference range of 0 to 100 PSI inclusive of all effects.
      h. Measurement Range: Select the measurement range offered by the instrument manufacturer for the specified model series that offers the greatest available accuracy for the required span of measurement as listed in the Instrument List shown in the PLANS.
      i. Indicator Requirements:
         1) Type: Digital LCD integral to transmitter
         2) Calibration: Field configurable, as desired by the user
            a) Span: As listed in the Instrument List shown in the PLANS.
            b) Measurement Unit: As listed in the Instrument List shown in the PLANS.

j. Power: Loop powered (4-20mA at 24 VDC) with 1/2" NPT conduit connection.
k. Sensor Wetted Parts Material: Type 316L Stainless Steel.
l. Sensor traditional bottom works, process covers and process connectors:
   1) Type 316-Stainless Steel with supply vent screw inside of each process cover with traditional bottom works (not coplanar) configuration.
m. Sensor Fill Fluid: Silicone oil.
n. Process Connection: 1/2-inch NPT.
o. Transmitter Housing: Epoxy coated aluminum, NEMA-4X.
p. Hardware: Type 316 Stainless Steel.
q. Local Operation: The Indicator/Transmitter shall be equipped with operators on the face of the unit adjacent to the local indicator for configuration and calibration functions. The face of the unit is the side of the unit that includes the local indicator.

2. Process Pipe Pressure Tap Valves: Refer to PLANS for valving on process piping pressure tap, in addition to any instrument valves specified in this section.
3. Mounting: Manufacturer's Type 316 Stainless Steel mounting bracket suitable for mounting transmitter assembly on 2-inch pipe stand, support channel, wall/panel or other surface as shown on PLANS with manifold installed between transmitter and bracket. Provide stainless steel flange to mount vertical pipe stand to floor. Refer to the PLANS for additional requirements.
4. Each Intelligent Pressure Measuring Indicator/Transmitter shall be as manufactured by Endress+Hauser Cerabar PMP series for (Intelligent Gauge and Absolute Pressure Transmitters) as noted for application with specified accessories, or Owner/Engineer approved equal.

B. P101 Series General Requirements:
1. The Pressure Indicator/Transmitter shall have the following features:
   a. Signal: Two-wire 4-20mAdc (loop powered) proportional and linear to Pressure with HART communication protocol.
      1) Alarm: Configure the unit fault/alarm at 3.6 mAdc output signal.
   b. Accuracy:
      1) Up to 0.075%
   c. Ambient Temperature Range: -76°F to +185°F.
   d. Process Temperature Range: -40°F to +257°F.
   e. DC Loop Supply Voltage Range: 10.5 to 35 VDC.
   f. Measurement Range: Select the measurement range offered by the instrument manufacturer for the specified model series that offers the greatest available accuracy for the required span of measurement as listed in the Instrument List shown in the PLANS.
   g. Indicator Requirements:
      1) Type: Digital LCD integral to transmitter with touch control and Bluetooth capabilities
   h. Calibration: Field configurable, as desired by the user
      1) Span: As listed in the Instrument List shown in the PLANS.

2) Measurement Unit: As listed in the Instrument List shown in the PLANS.

i. Power: Loop powered (4-20mA at 24 VDC) with 1/2" NPT conduit connection.
j. Sensor Wetted Parts Material: Type 316L Stainless Steel.
k. Sensor traditional bottom works, process covers and process connectors:
   1) Type 316-Stainless Steel with supply vent screw inside of each process cover with traditional bottom works (not coplanar) configuration.
l. Sensor Fill Fluid: Silicone oil.
m. Process Connection: 1/2-inch NPT.
n. Transmitter Housing: Epoxy coated aluminum, NEMA-4X.
o. Hardware: Type 316 Stainless Steel.
p. Local Operation: The Indicator/Transmitter shall be equipped with operators on the face of the unit adjacent to the local indicator for configuration and calibration functions. The face of the unit is the side of the unit that includes the local indicator.
q. Specialties: Secure Bluetooth connection

2. Process Pipe Pressure Tap Valves: Refer to PLANS for valving on process piping pressure tap, in addition to any instrument valves specified in this section.
3. Mounting: Manufacturer's Type 316 Stainless Steel mounting bracket suitable for mounting transmitter assembly on 2-inch pipe stand, support channel, wall/panel or other surface as shown on PLANS with manifold installed between transmitter and bracket. Provide stainless steel flange to mount vertical pipe stand to floor. Refer to the PLANS for additional requirements.
4. Each Pressure Measuring Indicator/Transmitter shall be as manufactured by Endress+Hauser Cerabar PMP71B as noted for application with specified accessories, or Owner/Engineer approved equal.

C. P102: Pressure Indicating Transmitter with Block Valve
   1. General Requirements for P101 Series Pressure Indicating Transmitters apply to this type of instrument.
   2. Instrument Valves: Provide factory furnished, 2-way Valve Block Manifold; constructed of 316 Stainless Steel wetted and non-wetted parts, to accept 1/2-inch NPT; with gaskets and 316 Stainless Steel bolts; Refer to PLANS for additional valving on process piping pressure tap and mounting.
   3. Mounting of Manifold and Transmitter: Mount manifold directly with specified manifold mounting bracket. Manifold shall be installed between Transmitter bottom works and bracket. Transmitter shall be supported by manifold.

D. P103: Pressure Indicating Transmitter with Integral Threaded Diaphragm Seal:
   1. General Requirements for P101 Series Pressure Measuring Indicating Transmitters apply to this type of instrument.

a. Exception: The Type P103 Pressure Measuring Indicator/ Transmitter shall not have a bottom works (traditional or coplanar).

2. Pressure Seal Requirements:
   a. Temperature Error: Less than 0.1% instrument error based on the listed pressure span when the volume of fill fluid is subject to a 30-degree Fahrenheit change in temperature.
   b. Pressure Ratings: Rated for same pressure as the process piping system that it serves and shall be continuous-duty design rated to prevent loss of process fluid if pressure instrument is removed or fails.
   c. Fill Fluid: Inert fill fluid shall be used where the process fluid is a strong oxidizing agent, including but not limited to, oxygen, chlorine, fluorine, nitric acid, and hydrogen peroxide.
   d. Material Compatibility: For process fluids not noted in this Specification Section, coordinate with the Diaphragm Seal Factory for recommended material compatibility and submit to Owner/Engineer for review.
3. Diaphragm Pressure Seal: Provide factory furnished, factory assembled pressure transmitter assembly including diaphragm seal with fill fluid factory filled and sealed or Owner/Engineer approved equal. Provide seal system to comply with the following requirements:
   a. Type: Integral mount, One Seal System
   b. Size: 4-inch diameter diaphragm
   c. Process Connector: 1” threaded NPT, internal threads
   d. Pressure Rating: Housing, diaphragm and bolt system rated for 750 psig minimum process fluid pressure
   e. Lower Housing Material (Process Wetted): 316 Stainless Steel
   f. Diaphragm Material: 316L Stainless Steel
   g. Upper Housing Material: 316L Stainless Steel
   h. Gasket: Teflon (PTFE)
   i. Instrument Connection: Factory installed diaphragm seal onto the transmitter. Orient and position the diaphragm seal relative to the required side of the transmitter bottom works to allow the installation of the transmitter and to provide a fully accessible and functional system. Refer to PLANS for additional requirements.
   j. Flushing Connector: Two (2) 1/2" NPT on each side of lower housing, with plug having same material as lower housing.
   k. Bolting: Type 316 Stainless Steel
   l. Fill Fluid: DC200, 10 cSt Silicone

E. P104: Pressure Indicating Transmitter with Remote Threaded Diaphragm Seal
   1. General Requirements for P101 Series Intelligent Pressure Measuring Indicating Transmitters apply to this type of instrument.
   2. Pressure Seal Requirements:
      a. Temperature Error: Less than 0.1% instrument error based on the listed pressure span when the volume of fill fluid is subject to a 30-degree Fahrenheit change in temperature.
      b. Pressure Ratings: Rated for same pressure as the process piping system that it serves and shall be continuous-duty design rated to

prevent loss of process fluid if pressure instrument is removed or fails.

c. Fill Fluid: Inert fill fluid shall be used where the process fluid is a strong oxidizing agent, including but not limited to, oxygen, chlorine, fluorine, nitric acid, and hydrogen peroxide.
d. Material Compatibility: For process fluids not noted in this Specification Section, coordinate with the Diaphragm Seal Factory for recommended material compatibility and submit to Owner/Engineer for review.

3. Diaphragm Pressure Seal and Capillary Tubing: Provide factory furnished, factory assembled pressure transmitter assembly including capillary tubing and diaphragm seal, with fill fluid factory filled and sealed or Owner/Engineer approved equal. Provide seal system to comply with the following requirements:
   a. Type: Remote mount, One Seal System
   b. Size: 4-inch diameter diaphragm
   c. Process Connector: 1” threaded NPT, internal threads
   d. Pressure Rating: Housing, diaphragm and bolt system rated for 750 psig minimum process fluid pressure
   e. Lower Housing Material (Process Wetted): 316 Stainless Steel
   f. Diaphragm Material: 316L Stainless Steel
   g. Upper Housing Material: 316L Stainless Steel
   h. Gasket: Teflon (PTFE)
   i. Instrument Connection: 1/4" NPT Capillary welded to transmitter.
   j. Flushing Connector: Two (2) 1/2" NPT on each side of lower housing, with plug having same material as lower housing.
   k. Bolting: Type 316 Stainless Steel
   l. Fill Fluid: DC200, 10 cSt Silicone
   m. Capillary Internal Diameter: 0.040 inches
   n. Capillary Type: Type 316L Stainless Steel Flexible Armor with Protective Coat
   o. Capillary Outer Diameter: 0.294 inches, including flexible armor and protective coat.
   p. Capillary Length: Size length of tubing to suit installed conditions and to allow a minimum of 3 feet and a maximum of 8 feet of slack.

F. P105: Pressure Indicating Transmitter with Diaphragm Seal for Corrosive Chemical Process Fluid Applications
   1. General Requirements for P101 Series Pressure Measuring Indicating Transmitters apply to this type of instrument.
   2. Diaphragm Seals: Provide factory furnished, factory assembled pressure transmitter assembly including capillary tubing and diaphragm seal, with fill fluid factory filled and sealed or approved equal. Provide seal system to comply with the following requirements:
      a. Process Connector: 1” threaded NPT, internal threads
      b. Pressure Rating: Housing, diaphragm and bolt system rated for 200 psig minimum process fluid pressure
      c. Lower Housing Material (Process Wetted): Kynar (PVDF)
      d. Diaphragm Material: Teflon (PTFE)
      e. Alternate Material Selection: If lower housing and diaphragm materials listed above do not comply with specific process fluid

temperature, pressure, chemical compatibility, and other process fluid parameters, provide alternate material for review and approval by OWNER/ENGINEER
1) Exception: Provide Type 316 Stainless Steel in lieu of Type 304 Stainless Steel.

f. Upper Housing Material: 316L Stainless Steel
g. Gasket: Teflon (PTFE)
h. Instrument Connection: 1/4" NPT Capillary welded to transmitter.
i. Flushing Connector: No
j. Bolting: 300 Series Stainless Steel
k. Fill Fluid: DC200, 10 cSt Silicone
l. Capillary Internal Diameter: 0.040 inches
m. Capillary Type: Flexible Armor with Protective Coat
n. Capillary Length: Size length of tubing to suit installed conditions and to allow a minimum of 3 feet and a maximum of 8 feet of slack.

G. P106: Pressure Indicating Transmitter with Diaphragm Seal for Oxidizing Chemical Process Fluid Applications (Sodium Hypochlorite, Chlorine, etc.)
1. General Requirements for P101 Series Pressure Measuring Indicating Transmitters apply to this type of instrument.
2. Diaphragm Seals: Provide factory furnished, factory assembled pressure transmitter assembly including capillary tubing and diaphragm seal, with fill fluid factory filled and sealed or approved equal. Provide seal system to comply with the following requirements:
a. Process Connector: 1” threaded NPT, internal threads
b. Pressure Rating: Housing, diaphragm and bolt system rated for 200 psig minimum process fluid pressure
c. Lower Housing Material (Process Wetted): PVC
d. Upper Housing Material: Titanium
e. Diaphragm Material: Teflon (PTFE)
f. Alternate Material Selection: If lower housing and diaphragm materials listed above do not comply with specific process fluid temperature, pressure, chemical compatibility, and other process fluid parameters, provide alternate material for review and approval by OWNER/ENGINEER
g. Gasket: Teflon (PTFE)
h. Instrument Connection: 1/4" NPT Capillary welded to transmitter.
i. Flushing Connector: No
j. Bolting: 300 Series Stainless Steel
k. Fill Fluid: FC77, Fluorinert
l. Capillary Internal Diameter: 0.040 inches
m. Capillary Type: Flexible Armor with Protective Coat
n. Capillary Length: Size length of tubing to suit installed conditions and to allow a minimum of 3 feet and a maximum of 8 feet of slack.

H. P110 Series General Requirements:
1. The Industrial Pressure Transmitter shall have the following features:
a. Accuracy: Up to 0.25%
b. Measurement Range: Select the measurement range offered by the instrument manufacturer for the specified model series that offers

the greatest available accuracy for the required span of measurement as listed in the Instrument List shown in the PLANS.

c. Housing Type: General Purpose SS - NEMA 4X IP66
d. Fittings: 1/2" Male NPT
e. Cables and Connectors: Hirschmann DIN Plug or 9ft Factory Cable
f. Electrical Output: 4-20 mA, 2-wire
g. Options: NSF Certification
h. Wetted Material: Type 316L Stainless Steel
i. Power Requirements: 10 to 30 VDC
j. Output Signal: 4 to 20 mA, 0 to 5 VDC, 1 to 5 VDC, 0 to 10 VDC, or 0.5 to 4.5 VDC
k. Temperature Limit:0 to 200°F (-18 to 93°C)

2. Process Pipe Pressure Tap Valves: Refer to PLANS for valving on process piping pressure tap, in addition to any instrument valves specified in this section.
3. Each Industrial Pressure Transmitter shall be as manufactured by Dwyer Series 626 as noted for application with specified accessories, or Owner/Engineer approved equal.

2.03 MISCELLANEOUS EQUIPMENT, TOOLS, AND ACCESSORIES

A. Instrument Tubing: Provide instrument tubing to process line connections at valve block process port/diaphragm seal/instrument. Refer to tubing and fittings requirements Specification Section. Refer to PLANS for additional requirements.

2.04 SPARE PARTS

A. Provide twenty percent or one complete set, whichever is greater, of each type of pressure transmitter utilized with specified accessories.

PART III - EXECUTION

3.01 INSTALLATION

A. General: The following apply to all products in this Section:

1. Unless otherwise specified, all instrument mounting channels, pipes, pipe caps, etc. shall be Type 316 stainless steel; also, all hardware connecting and securing the mounting hardware and instruments such as nuts, bolts, instrument tubing Cush-A-Clamp Assembly Pipe/Tube Clamp etc. shall be Type 316 Stainless Steel.

2. All field mounted sensor/control/instrument devices shall be permanently identified. The device designations shall agree with those shown on the PLANS. Each device shall be provided with permanent type

identifying nameplate. Refer to Specification Section 17200 for requirements.

3.02 TESTING AND INSPECTION

A. Refer to Section 17100

3.03 TRAINING

A. Start-up Training: Provide required instruction to the Owner's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for no less than **TWO (2) SESSIONS** for the purpose of instructing the Owner's personnel in the correct operating and maintenance procedures for all the instruments. This is in addition to the training requirements defined in Section 17100 of the Contract Specifications. The dates of this school shall be scheduled with the Owner. Also, refer to the additional training requirements defined in Section 17200 of the Contract Specifications.

3.04 MEASUREMENT AND PAYMENT

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

3.05 WARRANTY

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents.

B. Warrant equipment free of defects in material and workmanship for 2-years; cover parts and labor. Manufacturer's warranty shall be issued in the Owner's name.

END OF SECTION

PART I - GENERAL

1.01 THE REQUIREMENT

A. General: The CONTRACTOR shall provide temperature gauges, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17100 - Process Control and Instrumentation Systems apply to this Section.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 17100 - Process Control and Instrumentation Systems.

B. Submit product information cut sheets containing manufacturer's specifications, Operations and maintenance data, instrument enclosure type, installation location, and process temperature range to be supplied. Indicate product part number in full.

C. Provide submittals in accordance with Section 01300, and elsewhere in the Contract Documents.

PART II - PRODUCTS

2.01 TEMPERATURE GAUGES

A. Bi-metal, NEMA 4X, hermetically sealed temperature gauges with 304 stainless steel casing shall be furnished as detailed in the instrument schedule and installed in accordance with the Manufacturer's requirements. Furnished gauges shall be 3-inch diameter and scaled in Fahrenheit. Gauges shall be as manufactured by:

1. Wika, Model 55

2. Or ENGINEER approved equal.

PART III - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed and connected as specified and shown on the drawings. Contractor shall coordinate with mechanical and piping to insure proper connection to piping and/or other mechanical equipment.

3.02 ACCEPTANCE

A. As a condition precedent to final acceptance of the work, the contractor shall certify the equipment and installation included under this section to

be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's guarantee.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Provide all labor, materials, and equipment to design, furnish, install, calibrate, test, adjust, and place in operation all instrumentation as specified herein and as shown on the Contract Documents.

B. Instrument Type Code:

1. An Instrument Type Code identifies each instrument and consists of an alphabetical character(s) followed by three numeral characters.

    a. Example Instrument Type Code: "A123".

2. The Type Code serves as a means to reference each instrument in the specifications.

1.02 RELATED REQUIREMENTS

A. Refer to Section 17100

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

C. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.03 SUBMITTALS

A. Submit the following in accordance with the Section 01330 and 01730 of the Specifications and in accordance with Section 17100 of the Specifications:

1. Shop Drawings and product data.

2. Submit wiring schematics for all equipment.

3. Submit listing of all field instruments tag numbers for verification by OWNER.

4. Test Reports: Completed and certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.

    a. Include factory calibration for each instrument with stated accuracy.

5. Operation and maintenance manuals.

    a. Include all completed and certified test reports in manuals.

        1) Refer to specifications herein for transmitter ambient and process fluid temperature ranges to be used for basis of accuracy analysis.

6. Submit detailed listing of training class curriculum including, as a minimum, the following at least four (4) months prior to class:

    a. Specific topics for each instrument, including but not limited to, general troubleshooting, calibration, wiring, and general set-up/configuration.

    b. Anticipated duration of class for each instrument type.

    c. Names of instructor(s) for each specific instrument.

    d. Refer to instrument by Instrument Type Code as listed in this specification section where applicable.

1.04 QUALITY ASSURANCE

A. Standardization: All equipment of the same Instrument Type Code to be the product of a single manufacturer.

B. Examine the complete set of Contact Documents and verify that the instruments are compatible with the installed conditions including:

    1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

    2. Physical conditions:

        a. Installation and mounting requirements.

        b. Location within the process.

        c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the ENGINEER if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Material Compatibility:

    1. Material selections of instrument components noted in this section provide a basis for the minimum material compatibility requirements.

2. Instrument component material selections shall be subject to additional restrictions and compliance with recommendations of instrument manufacturers for the intended service.

3. Provide instrument component materials in compliance with specific process fluid temperature, pressure, chemical compatibility, and other process fluid parameters.

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. See Below for Approved Manufacturers Per Radar Level Transmitter Type

2.02 MATERIALS/CONSTRUCTION

A. L200 Series General Requirements:
   1. The Radar Level Transmitter shall have the following features:
      a. Measuring Range: 0-49ft
      b. Housing Material: Plastic
      c. Protection Rating: IP66/IP67, Type 4X
      d. Output: 4-20 mA/HART
      e. Process Temperature: -40-176 °F
      f. Ambient Temperature: -40-158 °F
      g. Accuracy: ± 2 mm
      h. Frequency: 80 GHz
      i. Beam Angle: 8°
      j. Materials, Wetted Parts: PVDF
      k. Process Fitting: Threaded 1.5” NPT
      l. Cable Entry: ½” NPT
      m. Accessories:
         1) Bluetooth
         2) Protective Cover
   2. Manufacturer: VEGAPULS 31 or approved equal

B. L201 Series General Requirements:
   1. The Radar Level Transmitter shall have the following features:
      a. Measuring Range: 0-98ft
      b. Process Fitting: Threaded 1.5” NPT
      c. Process Material: 316L
      d. Housing Material: Aluminum
      e. Protection Rating: IP66/IP67
      f. Output: 4-20 mA/HART
      g. Process Temperature: -320-392 °F
      h. Ambient Temperature: -40-176 °F
      i. Accuracy: ± 1 mm
      j. Frequency: 80 GHz
      k. Beam Angle: 3°
      l. Materials, Wetted Parts: PTFE

m. Cable Entry: ½" NPT
n. Accessories:
   1) Bluetooth
   2) Magnetic Pen
   3) Protective Cover

2. Manufacturer: VEGAPULS 64 or approved equal

C. L202 Series General Requirements:
1. The Radar Level Transmitter shall have the following features:
   a. Measuring Range: 0-49ft
   b. Housing Material: Plastic
   c. Protection Rating: IP66/IP67, Type 4X
   d. Output: 4-20 mA/HART
   e. Process Temperature: -40-176 °F
   f. Accuracy: ± 2 mm
   g. Frequency: 80 GHz
   h. Beam Angle: 8°
   i. Materials, Wetted Parts: PVDF
   j. Process Fitting: Threaded 1.5" NPT & 1" NPT
   k. Accessories:
      1) Bluetooth
      2) VEGADIS 82 External Display
         a) Housing Material: NEMA 4X minimum
         b) HART communication protocol
2. Manufacturer: VEGAPULS C21 or approved equal
   a. Operating Voltage: 12 – 35 VDC

2.03 SPARE PARTS

A. Provide twenty percent or one complete set, whichever is greater, of each type of radar level transmitter utilized with specified accessories.

PART III - EXECUTION

3.01 INSTALLATION

A. General: The following apply to all products in this Section:

1. Unless otherwise specified, all instrument mounting channels, pipes, pipe caps, etc. shall be Type 316 stainless steel; also, all hardware connecting and securing the mounting hardware and instruments such as nuts, bolts, instrument tubing Cush-A-Clamp Assembly Pipe/Tube Clamp etc. shall be Type 316 Stainless Steel.

2. All field mounted sensor/control/instrument devices shall be permanently identified. The device designations shall agree with those shown on the PLANS. Each device shall be provided with permanent type

identifying nameplate. Refer to Specification Section 17200 for requirements.

3.02 TESTING AND INSPECTION

A. Refer to Section 17100

3.03 STORAGE, HANDLING AND PROTECTION

A. Refer to Section 17100

3.04 TRAINING

A. Start-up Training: Provide required instruction to the Owner's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for no less than **TWO (2) SESSIONS** for the purpose of instructing the Owner's personnel in the correct operating and maintenance procedures for all the instruments. This is in addition to the training requirements defined in Section 17100 of the Contract Specifications. The dates of this school shall be scheduled with the Owner. Also, refer to the additional training requirements defined in Section 17200 of the Contract Specifications.

3.05 MEASUREMENT AND PAYMENT

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

3.06 WARRANTY

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents.

B. Warrant equipment free of defects in material and workmanship for 2-years; cover parts and labor. Manufacturer's warranty shall be issued in the Owner's name.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Provide all labor, materials, and equipment to design, furnish, install, calibrate, test, adjust, and place in operation all instrumentation as specified herein and as shown on the Contract Documents.

B. Instrument Type Code:

1. An Instrument Type Code identifies each instrument and consists of an alphabetical character(s) followed by three numeral characters.

    a. Example Instrument Type Code: "A123".

2. The Type Code serves as a means to reference each instrument in the specifications.

1.02 RELATED REQUIREMENTS

A. Refer to Section 17100

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

C. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.03 SUBMITTALS

A. Submit the following in accordance with the Section 01330 and 01730 of the Specifications and in accordance with Section 17100 of the Specifications:

1. Shop Drawings and product data.

2. Submit wiring schematics for all equipment.

3. Submit listing of all field instruments tag numbers for verification by OWNER.

4. Test Reports: Completed and certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.

    a. Include factory calibration for each instrument with stated accuracy.

5. Operation and maintenance manuals.

    a. Include all completed and certified test reports in manuals.

        1) Refer to specifications herein for transmitter ambient and process fluid temperature ranges to be used for basis of accuracy analysis.

6. Submit detailed listing of training class curriculum including, as a minimum, the following at least four (4) months prior to class:

    a. Specific topics for each instrument, including but not limited to, general troubleshooting, calibration, wiring, and general set-up/configuration.

    b. Anticipated duration of class for each instrument type.

    c. Names of instructor(s) for each specific instrument.

    d. Refer to instrument by Instrument Type Code as listed in this specification section where applicable.

1.04 QUALITY ASSURANCE

A. Standardization: All equipment of the same Instrument Type Code to be the product of a single manufacturer.

B. Examine the complete set of Contact Documents and verify that the instruments are compatible with the installed conditions including:

    1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

    2. Physical conditions:

        a. Installation and mounting requirements.

        b. Location within the process.

        c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the ENGINEER if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Material Compatibility:

    1. Material selections of instrument components noted in this section provide a basis for the minimum material compatibility requirements.

2. Instrument component material selections shall be subject to additional restrictions and compliance with recommendations of instrument manufacturers for the intended service.

3. Provide instrument component materials in compliance with specific process fluid temperature, pressure, chemical compatibility, and other process fluid parameters.

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. See Below for Approved Manufacturers Per Level Switch Type

2.02 MATERIALS/CONSTRUCTION

A. L400 Series General Requirements:
   1. The Non-metallic tilting Float Level shall have the following features:
      a. Float Construction: Corrosion resistant PVC
      b. Certification: U. L. Listed
      c. Switch:
         1) Mounted integrally with float and mechanically activated with float position.
         2) Opens/Closes on the level condition as described on the PLANS. Refer to the PLANS.
         3) Single-pole-double-throw (SPDT) and rated 13 Amp inductive load at 120VAC.
         4) Switch shall **NOT** contain mercury.
      d. Cable Connection:
         1) Flexible 16 AWG, 3-conductor SJOW-A water resistant cable integrally connected to float body.
         2) Of sufficient length to be routed without any splice to the cable termination box as shown in PLANS.
         3) Coil a minimum of 4 feet of slack of level switch cable within the cable termination box.
      e. Mounting:
         1) Provide all necessary mounting hardware for a secure installation of level switch complete with cable weights, clamps, suspension cabling, anchor weight, and other miscellaneous accessories.
         2) Comply with the additional requirements as shown on the PLANS
   2. Each level switch shall be as manufactured by SJE PumpMaster SPDT, Sump Alarm Sludge Boss, or approved equal.

B. L401 Series General Requirements:
   1. The metallic Float Level SPST Switch with the following features:
      a. Stem and Mounting Construction Material: 316 Stainless Steel
      b. Float Material: Buna N
      c. Certification: UL Recognized
      d. Switch:
         1) SPST and 20VA rated switch

2. The level switch shall be the GEMS Sensors & Controls 1702 or approved equal.

2.03 FLOAT TYPE LIQUID LEVEL SWITCHES

A. Liquid level (mercury-free) switches shall be the side mounted float actuated type. Float switches shall be SPDT and shall consist of a fixed sealed reed switch actuated by a floating magnet. Level switches shall be flange or plug mounted to suit field requirements. Process wetted materials shall be Teflon.

B. Liquid level switches shall be as manufactured by **MAGNETROL "TUFFY"** or Engineer approved equal.

2.04 TIPPING FLOAT LEVEL SWITCHES

A. Tipping float (mercury-free) level switches shall consist of a switch, a moving float, and a connecting cable which is anchored at the midpoint of a differential band. As the level rises and falls the float rights itself or inverts causing switching actions. The cable anchoring point shall be protected by strain relief. The hermetically sealed switches shall be SPDT with a minimum rating of 10 Amps at 120 VAC. Process wetted materials shall be Teflon.

B. Tipping float level switches shall be as manufactured by:

1. MAGNETROL Model T10 for non-hazardous locations

2. MAGNETROL Model T20/21 for hazardous Class I Division 1 locations

3. Or Engineer approved equal.

2.05 MISCELLANEOUS EQUIPMENT, TOOLS, AND ACCESSORIES

A. Provide mounting brackets, hardware, and other miscellaneous equipment

2.06 SPARE PARTS

A. Provide twenty percent or one complete set, whichever is greater, of each type of level switch utilized with specified accessories.

PART III - EXECUTION

3.01 INSTALLATION

A. General: The following apply to all products in this Section:

1. Unless otherwise specified, all instrument mounting channels, pipes, pipe caps, etc. shall be Type 316 stainless steel; also, all hardware connecting and securing the mounting hardware and instruments such as nuts, bolts, instrument tubing Cush-A-Clamp Assembly Pipe/Tube Clamp etc. shall be Type 316 Stainless Steel.

2. All field mounted sensor/control/instrument devices shall be permanently identified. The device designations shall agree with those shown on the PLANS. Each device shall be provided with permanent type identifying nameplate. Refer to Specification Section 17200 for requirements.

3.02 TESTING AND INSPECTION

A. Refer to Section 17100

3.03 TRAINING

A. Start-up Training: Provide required instruction to the Owner's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for no less than **TWO (2) SESSIONS** for the purpose of instructing the Owner's personnel in the correct operating and maintenance procedures for all the instruments. This is in addition to the training requirements defined in Section 17100 of the Contract Specifications. The dates of this school shall be scheduled with the Owner. Also, refer to the additional training requirements defined in Section 17200 of the Contract Specifications.

3.04 MEASUREMENT AND PAYMENT

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

3.05 WARRANTY

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents

B. Warrant equipment free of defects in material and workmanship for 2-years; cover parts and labor. Manufacturer's warranty shall be issued in the Owner's name.

END OF SECTION

PART I - GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment, and incidentals required, and shall install complete, ready for operation, and test the distributed control system, hereinafter termed the System as shown on the PLANS and as specified.

B. The Instrument and Control System Contractor (ICS) shall provide equipment, materials, software, calibrations, startup assistance and system check-out, and other services that are required to successfully interface and interconnect the System and associated equipment that are specified or designated in PLANS or provisions of these specifications for the purpose of providing a fully integrated and functional control system as specified.

C. The ICS shall be responsible for all modifications to the Owner's existing distributed control system as also shown on the PLANS.

D. Refer to the PLC Input/Output Schedule and wiring schematics on the PLANS and other subsections of this Specification Section for requirements related to the PLC Input/Output.

1.02 DISTRIBUTED CONTROL SYSTEM DESCRIPTION

A. General:

1. The Distributed Control System (DCS) as shown on the PLANS and specified herein, includes, but is not limited to, the following:

   a. Programmable Logic Controllers Subsystem (PLCs),

   b. Communication System Application and System Software,

   c. PLC networking/data communications over existing and proposed Ethernet TCP/IP network as well as Modbus Plus network.

   d. Interface with Power Monitoring Units, Protective Relays, and other devices as shown on the PLANS.

   e. Interface with process/mechanical equipment having packaged control systems as shown on the PLANS.

1.03 RELATED SPECIFICATIONS

A. Refer to Section 17100.

B. This Section covers work related to the Distributed Control System DCS and its Subsystems. Note that this Section does not stand-alone. Many key technical definitions, functional requirements, training, submittals, etc. requirements for the DCS are given in the Specifications.

1.04 SUBMITTALS

A. Submit the following:

1. Hardware:

   a. Shop drawings, product data, bill of materials

   b. Control system architecture block diagram

   c. Wiring diagrams

   d. Spare parts listing.

2. PLC I/O "Host Pack Template" Spreadsheets:

   a. The Owner has standard Excel spreadsheet templates, termed the "Host Pack Template" of enumerating information about the I/O points for the installation of the system. Upon completion of the system installation and PAT, the Owner shall supply to the ICS the Host Pack Template in Excel format for the contractor to complete.

   b. The Contractor is to complete and submit in Excel format the Owner provided Host Pack Template.

3. Operations and Maintenance O&M Manuals:

   a. Hardware: As minimum, provide the following:

      1) Final approved versions of all shop drawing submittals.

      2) Component Manufacturers' O&M Manuals including manuals to cover installation, operation, maintenance, troubleshooting, and calibration.

      3) List of spare parts and expendables provided, and list of spare parts recommended.

4. Refer to requirements in Specifications Section 17100 and Section 01730 of the Contract Specifications.

1.05 SPARE PARTS

A. Provide the following spare parts at minimum (round up to next whole number):

1. Provide the following SPARE equipment, complete with all accessories:

   a. PLC Processor Units (CPU Modules): Twenty percent (minimum of 1) of each type used

   b. PLC Power Supply Units: Ten Percent (minimum of 2) of the number required for each type of PLC used

   c. PLC RIO Head Module: Ten Percent (minimum of 1) of the number required for each type of PLC used

   d. PLC RIO Drop Module: Ten Percent (minimum of 1) of the number required for each type of PLC used

   e. PLC I/O Module (AI, AO, DI, DO): Ten Percent (minimum of 2) of the number of each type used.

   f. PLC Rack: One (1) of each type used.

   g. PLC Rack Extender Module complete with all accessories: One (1) of each type used.

   h. Ethernet Communication Module: Ten Percent (minimum of 2) of the number required for each type used.

   i. All spare parts shall be of the same manufacturer, model, and software revision as the installed component, and shall be provide complete with all accessories.

2. All spare parts shall be provided to the OWNER in the original manufacturer's packaging and shall be properly labeled. Equipment not provided in the original manufacturer's packaging will **NOT** be accepted.

PART II - PRODUCTS

2.01 GENERAL

A. Refer to Section 17100.

B. General Requirements:

1. Power source parameters:

   a. 120 volts A.C., plus or minus 10 percent, 60 Hertz

b. Regulators and power supplies required for compliance with the above shall be provided.

2. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

3. All components and interconnecting wiring shall be provided as required to satisfy the functional and operational requirements of this Specification.

4. All equipment to be installed in a control panel or on a rack, including switches, etc., shall be tagged according to the guidelines outlined in Section 17200 of these Specifications.

5. Unless otherwise specified, tag each outlet face plate with white Label with black lettering of minimum height ¼" where label is TTP Continuous polyester thermal transfer label as manufactured by Tyco, or approved equal, with ribbon and printer by label manufacturer.

6. Communication Cables: Provide all cables for interconnection between all components of the DCS inside the and/or in duct/conduit banks, as applicable. These cables shall include cables to the various PLCs I/O racks, power supplies, central processing units, patch panels, computers, etc. All cables shall be tagged per Section 17200 of these Specifications.

2.02 PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

A. Each programmable logic controller shall consist of central processor, process controller, power supply, memory, input/output, interconnecting cables, and optional items as specified.

B. Power Supply:

1. Manufacturer: MODICON M580 Automation Series model number BMX CPS 3500, No Equal.

2. Accessories: Provide screw clamp type removable terminal blocks, Modicon M580 model number BMX XTS CPS10, No Equal.

C. Central Processor:

1. Type 1 Programmable Logic Controllers (PLCs):

a. Manufacturer: Schneider Electric MODICON M580 BME P58 1020, No Equal.

2. Type 2 Programmable Logic Controllers (PLCs):

a. Manufacturer: Schneider Electric MODICON M580 BME P58 2040, No Equal.

3. Type 3 Programmable Logic Controllers (PLCs):

    a. Manufacturer: Schneider Electric MODICON M580 BME P58 4040, No Equal.

4. Accessories: Provide a 4 GB SD Memory Card, as manufactured by the CPU manufacturer.

D. Discrete Input Module (DI):

1. Manufacturer: MODICON M580 Automation Series Model number BMX DAI 1604, No Equal.

E. Discrete Output (DO):

1. Manufacturer: MODICON M580 Automation Series model number BMX DRA 0815, No Equal.

F. Analog Input Module (AI):

1. Manufacturer: MODICON M580 Automation Series model number BMX AMI 0810, No Equal. With each module, furnish and install cage clamp terminal block Modicon Model BMX FTB 2800, No Equal.

G. Analog Output Modules (AO):

1. Manufacturer: MODICON M580 Automation Series model number BMX AMO 0410, No Equal

H. Network Ethernet Communication Module (NOC):

1. Manufacturer: Modicon M580 Automation Series model number BME NOC 0301, No Equal.

I. DNP Communication Module:

1. Manufacturer: Modicon M580 Automation Series model number BME NOR 2200H, No Equal.

2. Accessories: Provide a 4 GB SD Memory Card, as manufactured by the CPU manufacturer

J. PLC Racks:

1. Manufacturer: MODICON Automation Series model number BME XBP 1200, No Equal

K. PLC Rack Extender Module:

1. Accessories:

    a. Provide X bus extender cord, length as required per PLANS,

manufactured by Extender Module manufacturer, model number BMX XBC series, No Equal.

b. Provide line terminator for extender module located at each end of the daisy chain, manufactured by the Extender Module manufacturer, model number TSXTLYEX, No Equal.

2. Manufacturer: MODICON M580 Automation Series model number BMX XBE 1000, No Equal

L. Remote I/O Drop Module:

1. Manufacturer: MODICON M580 Automation Series model number BME CRA 31210, No Equal.

M. Accessories:

1. Unless specified otherwise, provide 20-way screw clamp type removable terminal block with each module, Modicon Model BMX FTB 2010, No Equal.

2.03 OPERATOR INTERFACE UNITS (OIUs)

A. General:

1. The OIU shall effectively be a Graphical front end to the local PLC network and have complete read/write access to all registers of the local PLC network to which the OIU is connected.

a. Communication:

1) The OIU shall utilize Ethernet communication protocols to communicate to other peripheral devices, including PLC's, as shown in the contract drawings.

2) The ICS shall provide the necessary cabling for communicating with the OIU for programming and configuration purposes with a personal computer. The program cabling shall be USB and minimum of 12 feet in length.

3) The ICS shall install the necessary cabling, connectors, and termination for communication between the OIU Ethernet interface and the Ethernet network.

b. Software:

1) Operating System: Magelis Operating system, with latest service Pack, preinstalled by the OIU manufacturer.

2) Software: Vijeo Designer run time software, preinstalled by the OIU manufacturer.

3) All additional necessary software, software drivers, etc. complete will all licenses, as necessary for the proper operation of the OIU.

c. Mounting:

1) Mount in control panel door as shown on the Drawings. All communication ports shall be accessible with OIU installed in the control panel.

2) Provide mounting hardware as required and install OIU according to manufacturer's instructions and requirements. Provide trim accessories to seal the gap between the OIU and control panel door.

d. Accessories:

1) 1 Gigabyte secure digital (SD) card manufactured by the OIU manufacturer.

2) All necessary cables, connectors, and terminators. Minimum cable length shall be 12 feet

B. Type 1:

1. Display Module:

a. Type: Flat Color Active Matrix (TFT) LCD display type, with touch screen capability

b. Size: 15" diagonal

c. Power Input: 24 volts DC.

d. Enclosure: NEMA 4X rated

e. Manufacturer: Schneider Electric Harmony GTU HMIDT732, No Equal.

2. Box Module:

a. Power Input: 24 volts DC.

b. Memory:

1) System Card: SD Card 1 GB

2) Internal Memory: 256 MB RAM

3) Backup Memory: 512 kB NVRAM

c. Manufacturer: Schneider Electric Harmony GTU HMIG3U, No Equal.

C. Type 2:

1. Display Module:

a. Type: Flat Color Active Matrix (TFT) LCD display type, with touch screen capability

b. Size: 10” diagonal

c. Power Input: 24 volts DC.

d. Enclosure: NEMA 4X rated

e. Manufacturer: Schneider Electric Harmony GTU HMIDT542, No Equal.

2. Box Module:

a. Power Input: 24 volts DC.

b. Memory:

1) System Card: SD Card 1 GB

2) Internal Memory: 256 MB RAM

3) Backup Memory: 512 kB NVRAM

c. Manufacturer: Schneider Electric Harmony GTU HMIG3U, No Equal.

PART III - EXECUTION

3.01 SHIPMENT AND STORAGE

A. Storage: Refer to Specification Section 17100

3.02 GENERAL INSTALLATION AND PANEL ASSEMBLY

A. The ICS shall furnish labor, materials, equipment, and incidentals required to install the system in accordance with specifications.

B. The ICS shall be responsible for ensuring that field wiring for power and signal circuits is correct and wired in accordance with best industry practice. Also, the ICS shall be responsible for providing all necessary system grounding to insure a satisfactory functioning installation.

C. Dedicating Spare Channels for I/O Modules:

1. Discrete Input Module: Reserve point fifteen (15) and point sixteen (16) on each module as spare points.

2. Discrete Output Module: Reserve point eight (8) on each module as a spare point.

3. Analog Input Module: Reserve point eight (8) on each module as a spare point.

4. Analog Output Module: Reserve point four (4) on each module as a spare point.

3.03 TESTING

A. Refer to Section 17100

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

3.05 WARRANTY

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents

B. Warrant equipment free of defects in material and workmanship for 2-years; cover parts and labor. Manufacturer's warranty shall be issued in the Owner's name.

PART IV - TRAINING

4.01 GENERAL

A. Provide a training program for the OWNER’s personnel to address all equipment provided. The training program shall meet the specific needs of the OWNER and include the following subjects, at a minimum:

1. Hardware

    a. Specific training for the actual hardware configuration provided

b. Test, adjustment, calibration, troubleshooting, and component replacement procedures.

c. Provide a minimum of two (2) sessions

2. Software:

a. Operate the equipment on a day-to-day basis.

b. Make programming changes for all aspects of programming/configuration/functionality.

c. Configuration, troubleshooting, software installation procedures.

d. Assist the hardware maintenance technicians in diagnosing problems with the equipment.

e. Classes shall be designed for students having the equivalent of a one semester class on personal computers, but no professional programmable controller programming experience, OIU programming experience, or Ethernet switch configuration experience.

f. Provide a minimum of two (2) sessions

B. Additional training program requirements to be provided under the **Bid Allowance:**

1. Training duration:

a. Hardware: A minimum of one (1) session

1) Schneider Maintaining a Modicon PLC System

a) Course Code: TRNOSPLC34043

b. Software: Provide a minimum of one (1) session for each of the following:

1) Schneider EcoStruxure Control Expert for PLC's. Provide at minimum the following courses:

a) EcoStruxure Control Expert™ Level 1

I. Course Code: TRNOSPLCUTY13

b) EcoStruxure Control Expert™ Level 2

I. Course Code: TRNOSPLCUTY23

2) HMI / SCADA

a) Schneider VijeoDesigner Programming

I. Course Code: TRNOSHMIVDS13

b) iFix Fundamentals

I. Course Code: 154 (iFix Fundamentals)

II. Course Code: 254 (iFix Advanced)

C. Training Location: OWNER's designated facility located in Austin, Texas. Include all associated expenses.

D. Shift Quantity: Total of one shift, with a minimum ten (10) of the Owners personnel for each shift. Provide the training coordinated with the OWNER's schedule.

E. Personnel attending the training will be technical, managerial, administrative, engineers, and maintenance type personnel. The training shall accommodate instruction methods and materials accordingly.

END OF SECTION

PART I - GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment, and incidentals required, and shall install complete, ready for operation, and test the Distributed Control System, hereinafter termed the System as shown on the CONTRACT DOCUMENTS and as specified.

B. The Instrument and Control System Contractor (ICS) shall provide equipment, materials, software, calibrations, startup assistance and system check-out, and other services that are required to successfully interface and interconnect the System and associated equipment that are specified or designated in CONTRACT DOCUMENTS or provisions of these specifications for the purpose of providing a fully integrated and functional control system as specified.

C. The ICS shall be responsible for furnishing and installing the Communication System for the Distributed Control System "DCS" shown on the CONTRACT DOCUMENTS (installation and testing of the fiber optic cable, media converters, and validation of communication system), and as specified hereinafter.

D. The ICS shall be responsible for all modifications to the Owner's existing Distributed Control System as also shown on the CONTRACT DOCUMENTS.

E. The ICS shall coordinate with the OWNER all equipment configuration requirements prior to starting work.

1.02 DISTRIBUTED CONTROL SYSTEM DESCRIPTION

A. General:

1. The Distributed Control System (DCS) as shown on the CONTRACT DOCUMENTS and specified herein, includes, but is not limited to, the following:

   a. Programmable Logic Controllers Subsystem (PLCs)

   b. Communication System Application and System Software

   c. PLC networking/data communications over existing and proposed Ethernet IP networks.

   d. Interface with Power Monitoring Units, Protective Relays, and other devices as shown on the CONTRACT DOCUMENTS.

   e. Interface with process/mechanical equipment having packaged control systems as shown on the CONTRACT DOCUMENTS.

1.03 RELATED SPECIFICATIONS

A. Refer to Section 17100 and 17900.

B. This Section covers work related to the communications and its subsystems. Note that this Section does not stand-alone. Many key technical definitions, functional requirements, training, submittals, etc. requirements for the DCS are given in the Contract Specifications.

1.04 SUBMITTALS

A. Submit the following:

1. Hardware:

   a. Shop drawings, product data, bill of materials

   b. Control system architecture block diagram

   c. Wiring diagrams

   d. Spare parts listing

2. Fiber Optic Cable Plant Design: Submit fiber optic cable types, installation procedure, and fiber flux budget/gain margin calculations.

3. Fiber Optic and Ethernet System Copper Cable Testing Submittal: Provide a complete set of cable test results for the testing required under this Section of the Specifications. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications. Provide the OWNER with a typewritten result of all tests, including a description of the equipment tested, the date and time of day tested, test values, results. Test reports shall be signed by the ICS representative

4. Operations and Maintenance O&M Manuals:

   a. Hardware: As minimum, provide the following:

      1) Final approved versions of all shop drawing submittals.

      2) Component Manufacturers' O&M Manuals including manuals to cover installation, operation, maintenance, troubleshooting, and calibration.

      3) List of spare parts and expendables provided, and list of spare parts recommended.

5. Refer to requirements in Specifications Section 17100 and Section 01730 of the Contract Specifications.

1.05 SPARE PARTS

A. Provide the following spare parts at minimum (round up to next whole number):

1. Provide the following SPARE equipment, complete with all accessories:

   a. Local Area Network (LAN) system component (converter, modem, transceiver, etc.): Ten percent (minimum of 2) of each type provided

   b. All spare parts shall be of the same manufacturer, model, and software revision as the installed component, and shall be provide complete with all accessories.

2. All spare parts shall be provided to the OWNER in the original manufacturer's packaging and shall be properly labeled. Equipment not provided in the original manufacturer's packaging will **NOT** be accepted.

PART II - PRODUCTS

2.01 GENERAL

A. Refer to Section 17100.

B. General Requirements:

1. Power source parameters:

   a. 120 volts A.C., plus or minus 10 percent, 60 Hertz

   b. Regulators and power supplies required for compliance with the above shall be provided.

2. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

3. All components and interconnecting wiring shall be provided as required to satisfy the functional and operational requirements of this Specification.

4. All equipment to be installed in a control panel or on a rack, including switches, etc., shall be tagged according to the guidelines outlined in Section 17200 of these Specifications.

5. Unless otherwise specified, tag each outlet face plate with black Label with white lettering of minimum height ¼" where label is TTP Continuous polyester thermal transfer label as manufactured by Tyco, or approved equal, with ribbon and printer by label manufacturer.

6. Communication Cables: Provide all cables for interconnection between all components of the DCS inside the and/or in duct/conduit banks, as applicable. These cables shall include cables to the various PLCs I/O racks, power supplies, central processing units, patch panels, computers, etc. All cables shall be tagged per Section 17200 of these Specifications.

7. All equipment cabling, including copper Ethernet cable, all patch cords, etc., shall be tagged according to the guidelines and tagging labeling system outlined in Section 17200 of these Specifications. For tagging of cables with manufacturer pre-connected cable ends, e.g. patch cords, power cords, etc., furnish and install SP self-laminating polyester labels (minimum 2" long along length of cable) with thermal transfer printable, low profile translucent polyester film with a permanent acrylic adhesive as manufactured by Tyco, or approved equal, with respective printer and ribbon type by label manufacturer. Tag all S.O. type power cords with the tag of the equipment served.

2.02 ETHERNET COPPER CABLES AND CONNECTORS AND HARDWARE GENERAL SPECIFICATIONS REQUIREMENTS

A. General:

1. Provide and install copper cables, connectors, patch panels, and cords for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components herein shall be provided as minimum for bidding purposes.

2. Ethernet Copper Connectors: All copper Ethernet cables shall have a Category 6A boot type RJ-45 connector.

3. The installed Ethernet copper media system (including cable, data outlets, connectors, patch cords, patch panels, etc.) shall at minimum meet the TIA/EIA-568-C.2-10 Category 6A standards.

B. Ethernet Copper Patch Cords:

1. The Ethernet Copper Patch Cord shall be used to connect a communication device with a patch panel or Ethernet Copper Data Outlet. The Ethernet Copper Patch Cord shall also be used to connect devices directly to one another. At minimum, furnish and install copper patch cords for all Ethernet cabling between devices or between device and patch panel within the same cabinet. Refer to CONTRACT DOCUMENTS for required interconnections.

2. Each patch cord connector end shall be RJ-45 and shall be the Boot type connector. The connectors at each end shall be preinstalled by the Ethernet patch cord manufacturer

3. The Patch Cord shall be unshielded twisted pair and shall be rated Category 6A

4. The Ethernet copper cable outer jacket shall be Blue.

C. Patch panels:

1. General:

a. Approvals: Meet or exceed requirements for Category 6A per TIA/EIA- 568-C.2-10

b. In addition to the device/wire tagging requirements described in Section 17200, provide additional labels as described below:

1) Overall Connector Panel Labels: Printed on the patch panel case by the Manufacturer. Provide unique, alphanumeric designation

2) Connector Panel Adapter Port Label: Each adapter port on each Connector Panel shall have clearly labeled, printed, alphanumeric designation that is unique to that Connector Panel port and printed by the patch panel manufacturer

3) Terminate copper cabling to patch panel in accordance to TIA/EIA- 568-C.2-10 standards

4) Label each port of each patch panel. Furnish and install TTP Continuous polyester thermal transfer label as manufactured by Tyco, with ribbon and printer by label manufacturer. Label shall be white with black lettering of minimum height ¼"

c. Each patch panel shall be accompanied with a typed patch panel schedule with the following columns: Adapter ID, Cable Side, User Side, described as follows:

1) Adapter ID: The adapter ID shall be of the form XX-YY, where:

a) XX is the Connector Panel identifier shown by the panel manufacturer

b) YY shall represent the adapter number within the Connector Panel

2) Cable Side: Indicate the source of the cable. Use the "patch panel tag"-XX-YY designation where applicable

3) User Side: Indicates the device (PLC, patch panel, etc.) connected to the adapter

4) A Hard Copy print out of each Patch Panel Schedule shall be provided to the OWNER and ENGINEER. A soft copy on CD-R

media or flash drive of the patch panel schedule shall also be provided to the OWNER and ENGINEER

5) Employ consistent and uniform application of identifier and adapter numbering assignment to Ethernet Copper cables along the entire span and route of each copper cable.

2. Each Type 1 patch panel shall be as follows:

   a. Construction: Metal, primed and painted with manufacturer's standard black finish.

   b. Quantity of Ports: minimum 24.

   c. Miscellaneous: Color coded front port labeling.

   d. Mounting: 19" rack mountable. Mount on 19" rack, with all necessary brackets and hardware. Refer to the CONTRACT DOCUMENTS.

   e. Manufacturer: Panduit Mini-Com-series, Siemon, Hubbell, CommScope, or approved equal.

   f. Mounting Bracket: Where patch panel is to be mounted to a wall or back panel, furnish and install 1U Hinged Wall-Mount 19" rack Patch Panel Mounting Bracket for wall mounting the patch panel:

      1) Bracket shall be rated for minimum 8 kg (17 lbs.) weight capacity

      2) Bracket shall offset patch panel from wall by a minimum distance of 5.5".

      3) Bracket shall allow for wall or back panel mounting a patch panel while providing hinged access to the back of the patch panel to facilitate installation of Ethernet connectors and Ethernet cable termination.

      4) Bracket shall have mounting holes spaced 16" apart

      5) Bracket shall be painted steel hardware, minimum 14-gauge thickness, mounted with 316 stainless steel screws.

3. Each Type 2 patch panel shall be as follows:

   a. Construction: Metal, primed and painted with manufacturer's standard black finish

   b. Quantity of ports: 12

   c. Mounting: Panel or wall mount with manufacturer supplied screws, or approved equal

d. Manufacturer: "INTELLINET", Model: Cat6 Wall-mount Patch Panel, 12 Port, UTP, Part No.: 560269, or approved equal.

D. Copper Ethernet Data Communication Cabling:

1. Number of Pairs: Four
2. Wire Size: #23 AWG
3. Type of Conductors: solid copper conductors, twisted
4. Individual Conductor Insulation: 300-volt polyolefin
5. Individual Conductor Insulation Color: White/Blue Stripe, Blue, White/Orange Stripe, Orange, White/Green Stripe, Green, White/Brown Stripe, Brown
6. Drain Wire: No. 24 AWG Tinned copper
7. Overall Shield: Aluminum-mylar shield
8. Overall Jacket: PVC, include ripcord
9. Overall Jacket Color: Blue
10. Maximum Attenuation at 100 MHz: 18.9 dB per 100 meters of cable length
11. Maximum Attenuation at 250 MHz: 31.2 dB per 100 meters of cable length
12. Manufacturer: Belden, Catalog No. 7851A, or approved equal.
13. Agency Compliance: ANSI/TIA/EIA-568 B.2-1 Category 6

2.03 ETHERNET CONVERTER

A. Ethernet Media Converter: The Ethernet Media Converter shall be used for the conversion of Ethernet protocol between fiber optic and copper media. The Media Converter shall be as follows:

1. 24VDC power input rating.
2. DIN Rail mountable
3. Ports:
   a. One (1) 100Base-FX fiber port, with SC-Duplex connector. Refer to contract documents if Single Mode or Multi Mode fiber.

b. One (1) RJ45 10/100Base-TX copper port

4. Class 1 Div. 2 Rating

5. Operating temperature range: -40°C to 75°C

6. The Media Converter shall be as manufactured by Moxa IMC-21GA series or approved equal by Engineer/Owner

2.04 ETHERNET SWITCHES

A. Contractor shall contact AW SCADA Group (i.e. advise of testing procedures and schedule) a minimum of four (4) months prior to commencing testing.

B. AW SCADA Group shall provide configuration requirements for all Ethernet Switches to the Contractor.

C. Equipment shown below is typical equipment but is subject to change.

D. General:

1. Provide and install Ethernet switches for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components herein shall be provided as minimum for bidding purposes. It is anticipated that Ethernet Switch technology will advance over time and the latest model of Ethernet switch having the features specified hereinafter as a minimum shall be furnished and installed.

2. All switches shall be provided with the latest firmware from the manufacturer, where applicable. Switches to be stacked must be supplied with the same feature set, IP LAN, IOS, etc.

3. All switches shall be supplied with the manufacturer's support contract for the duration of two years starting from Substantial Completion of the project. At minimum switches manufactured by Cisco shall have the Cisco SMART NET technical support service for a **minimum of two (2) years starting from Substantial Completion** of the project and registered in the name of the Owner.

4. SFP Module: Each SFP module shall be the 1000BASE-LX/LH Long Haul module with duplex LC single mode connector. All SFP modules shall be as manufactured by Cisco. Where Drawings show an SFP module in the switch, furnish and install an SFP module onto the switch. Furnish and install SFP modules of minimum quantity to match that shown on the drawings for each switch.

5. For both rack mount style and DIN-Rail mount style, furnish and install

vertical wireway along each side of each switch as well as horizontal wireway above and below each switch.

6. Should the specified switch be designated as "End of Life" and/or discontinued by its manufacturer, contractor shall furnish and install an alternate switch, whose specifications meet or exceed the specified switch, by the same manufacturer and that is not designated as "End of Life" and/or discontinued by the switch manufacturer.

7. Ethernet Switch Inspection Report:

    a. For each Ethernet switch furnished, including spare, perform testing of the Ethernet switch as follows:

        1) Power up Ethernet switch and assure that no fault or error is indicated implying failure or malfunction of the switch.

        2) For each port and SFP module with specified SFP module inserted, perform the following tests

            a) Link light: assure link light correctly illuminate and extinguishes when an Ethernet copper or fiber link is established and disconnected, respectively.

            b) Data activity light: assure data activity light illuminates during data transport of the Ethernet switch port.

            c) Ping test: install Ethernet equipment to a specific port on the switch, herein after referred to as the "test" port, and successively install another IP equipment on each of the other ports and SFP modules on the switch. Perform an IP ping between the test port and each other port and SFP module on the switch to assure successful ping between the IP devices.

        3) Document the result of the tests in the Ethernet Switch Inspection Report. For each Ethernet switch, include the switch tag name (or spare), manufacturer, model number, and serial number. For each SFP Module, include the SFP Module manufacturer, model number, and serial number.

E. Type 1 Ethernet Switches:

1. Power Input: 120 volts A.C., 60 Hz.

2. Mounting: 19" rack mount

3. Port Quantity and Type: minimum 24 10/100/1000Base TX ports, 4 of which are dual purpose ports which the user may elect to use as a 10/100/10000Base TX port or as a socket for an SFP module.

4. Accessories:

a. For each Ethernet switch, furnish and install 120VAC Ethernet Switch power supply, model PWR-RGD-AC-DC-250 by Cisco. Where two (2) 120VAC power circuits are shown supplied to the Ethernet switch on the CONTRACT DOCUMENTS, furnish and install two (2) such power supply modules.

5. Manufacturer: Cisco Industrial Ethernet Switch IE-4010-4S24P.

6. Module: Provide minimum one (1) 1000BaseLX/LH SFP modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module with duplex LC single-mode connector.

F. Type 2 Ethernet Switches:

1. Power Input: 120 volts A.C., 60 Hz. Unit shall be equipped with its own power supply.

2. Mounting: Din Rail

3. Port Quantity and Type: minimum 48 10/100/1000Base TX ports, 4 of which are dual purpose ports which the user may elect to use as a 10/100/10000Base TX port or as a socket for an SFP or SFP+ module.

4. Module: Provide minimum 1 SFP 1000BaseLX/LH modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module. These SFP modules shall be included as part of the base bid.

5. Furnish and install second, redundant power supply for the Ethernet switch.

6. Accessories:

a. For each Ethernet switch, furnish and install DIN-rail adapter for back panel mounting model by Cisco.

b. LAN Base image

c. For each Ethernet switch, furnish and install 120VAC Ethernet Switch power supply, model PWR-IE170W-PC-AC= by Cisco. Where two (2) 120VAC power circuits are shown supplied to the Ethernet switch on the CONTRACT DOCUMENTS, furnish and install two (2) such power supply modules.

7. Manufacturer: Cisco Industrial Ethernet Switch IE-3300. Any subscription licensing shall be by the Owner.

G. Accessories:

1. Furnish and install mounting brackets and hardware as required to install each Ethernet Switch according to manufacturer's instructions and requirements

2. Furnish and install all necessary cables, connectors, and terminators as

required for a complete and functional installation

2.05 FIBER OPTIC CABLES AND CONNECTORS AND HARDWARE GENERAL SPECIFICATIONS REQUIREMENTS

A. General: Provide and install fiber-optic cables, connectors, panels, cords, and enclosures for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components specified herein shall be provided as minimum for bidding purposes.

B. Each fiber cable, as depicted on the CONTRACT DOCUMENTS, represents a minimum of two (2) fiber strands. A loose tube fiber cable, as depicted on the CONTRACT DOCUMENTS, represents the quantity of fiber strands equal to the loose tube fiber strand count as specified in this section of the specifications.

C. Fiber Optic Cables:

1. Unless specifically shown otherwise on the CONTRACT DOCUMENTS, all fiber optic cable shall be Type 1.

2. General Requirements for all types of Fiber Optic Cables:

a. All fiber optic cable shall be Loose tube fiber cable

b. Construction: Loose tube construction, allowing for thermal expansions and free movement of the fiber within the protective container.

c. Protective Coverings: Continuous and be of the same material, free from holes, splices, blisters, and other imperfections.

d. Flooding Compound: Applied into the interior of the fiber buffer tubes.

e. Strength members:

1) Integral part of the cable construction

2) Sufficient to support the stress of installation and to protect the cable in service.

f. Outer cable jacket: polyethylene (PE), except for the fiber that is run inside a building.

g. Additional Requirements:

1) Lightning resistant.

2) Fully water blocked.

h. Manufacturer: ALTOS loose tube type Fiber-Optic cable as manufactured by Corning Cable Systems LLC, or approved equal.

3. Each fiber optic cable shall be routed in a conduit that is dedicated only to that cable, and shall contain no other cable, unless explicitly noted in the drawings.

4. Optical fibers:

   a. Coated with a suitable material to preserve the intrinsic strength of the glass.

   b. Protected by a protective tube, a jacketed strength member, and an exterior jacket.

5. Glass cladding: Nominally concentric with the fiber core.

6. Each fiber shall be continuous with no factory splices

D. Fiber Optic Cable Terminations:

1. All fibers in all loose tube, fiber-optic cable ends shall be "fanned-out' using a Buffer Tube Fan-Out Kit for the respective cable to allow direct connection of the fiber-optic cable. Thereafter, all fibers shall be attached to a connector, of the respective type for that patch panel adapter in which the fiber is installed and of the same fiber mode as that of the cable.

2. In addition to the Buffer Tube Fan-Out, the fiber optic termination shall be accompanied by a furcation Unit and Loose tube Cable End kits. The Loose Tube Cable End terminates the cable jacket and aids in cable water blocking, as well as buffer tube strain relief. Furnish and install single mode kits and multi-mode kits corresponding to the type of fiber optic cable terminated.

3. Provide a minimum 20.0-foot coil of spare fiber in each manhole throughout the cable length.

4. Do not splice or terminate Fiber-Optic cable in underground electrical manholes and/or handholes.

5. All fiber optic cables shall be tested for performance and loss after termination and installation to verify that at least a 4dB power safety margin is obtained between all transmitters and receivers. Test data for each fiber and safety margin calculations for each fiber path shall be provided to the Owner and Engineer after installation to verify conformance with this specification.

6. Additional Requirements:

a. Terminate fiber optic cable only as shown on the CONTRACT DOCUMENTS. Do not splice fiber optic cables elsewhere.

b. Terminate all strands of a loose tube fiber optic cable in one, and only one, spider fan out kit.

E. Fiber Optic Connectors:

1. The fiber-optic device and the fiber cable end shall use the same type connectors.

2. All fiber strands associated with a Loose tube fiber cable shall have an "SC" connector at both ends of the strand.

3. An "SC-Duplex" connector is two (2) SC connectors abutted next to each other. Hence, a single "SC-Duplex" connector shall carry two fibers. Similarly, a single "SC-Duplex" adapter shall accept two fibers.

4. All outdoor Fiber Optic Cable shall be connectorized, at each end of the cable, to a patch panel located inside the building to which the cable is routed.

5. All fiber strands at both ends of each Fiber strand of a Fiber Optic Cable shall be terminated with an SC connector, where two such connectors are joined together to form a single mode "SC-Duplex" Connector. Where fiber strand terminates directly to a fiber/optic communication device (e.g., security camera device), connector type shall be the type as required to mate with connector(s) on device.

6. Use fusion splice-on type connectors, except for those patch cords which are to be pre-connectorized by the manufacturer. The connector shall be factory pre-polished connector and shall have a factory terminated pre-cleaved fiber strand pigtail that is suitable for machine aligned fusion splicing. The connector shall have a ceramic ultra-PC polish Zirconia ferrule, color coded buffer, cleave protector, splice protection boot, and dust protection cap. Connectors shall be "FIS Cheetah Splice-On Connector", or approved equal. The connector shall conform to the following:

a. Single-mode insertion loss (typical/maximum): 0.2db/0.3db. Multimode insertion loss (typical/maximum): 0.4db/0.5db.

b. The Insertion loss is the db loss across two (2) connectors, of the same type, which are mated with each other using a fiber optic adapter of that same type.

c. Durability: < 0.2 db per 500 reconnects.

d. All connectors shall have a ceramic zirconia ferrule and shall be Ultra PC polished.

F. Fiber-Optic Patch Panels:

1. General Requirements for Each Patch Panel:

a. Each port on a fiber optic patch panel, as depicted on the CONTRACT DOCUMENTS, represents an interconnection to a minimum of two (2) fiber strands. Those ports depicted on the CONTRACT DOCUMENTS connected to a loose tube fiber cable represents an interconnection to a minimum of the number of fiber strands within the loose tube fiber optic cable, in accordance to the loose tube fiber strand count as specified in this section of the specifications.

b. All Fiber Optic Cables shall be attached to connectors that are then manually inserted into adapters on the patch panel. The fiber optic may be attached by a means that is removable in the future, e.g., wire ties.

c. Labeling:

1) In addition to the device/wire tagging requirements described in Section 17200, provide additional labels as described below.

2) Overall Connector Panel Labels: Printed on the patch panel case by the Manufacturer. Provide unique, alphanumeric designation.

3) Connector Panel Adapter Label: Each adapter on each Connector Panel shall have clearly labeled, printed, alphanumeric designation that is unique to that Connector Panel and printed on the connector panel by the Manufacturer.

d. Each patch panel shall be accompanied with a typed patch panel schedule with the following columns: Adapter ID, Cable Side, User Side, described as follows:

1) Adapter ID: The adapter ID shall be of the form XX-YY, where:

a) XX is the Connector Panel identifier shown by the panel manufacturer

b) YY shall represent the adapter number within the Connector Panel.

2) Cable Side:

a) Indicate the source of the fiber optic strands. Use the "patch panel tag"-XX-YY designation where applicable.

3) User Side:

a) Indicates the device (PLC, patch panel, etc.) connected to the adapter.

4) A Hard Copy print out of each Patch Panel Schedule shall be provided to the OWNER and ENGINEER. A soft copy on CD-R media or flash-drive of the patch panel schedule shall also be provided to the OWNER and ENGINEER.

e. Employ consistent and uniform application of identifier and adapter numbering assignment to individual fiber strands along the entire span and route of each fiber optic cable.

2. Each Type 1 Fiber Optic Patch Panel shall be as follows:

a. Mounting: 19" rack mountable, with necessary brackets. Refer to the CONTRACT DOCUMENTS

b. Capacity: Up to six (6) connector panels

c. Connector Panels:

1) Six (6) SC Duplex adapters of ceramic type

4) Commence termination of panels from the left side of patch panel (when viewing front/user accessible side of panel), and leave right most panels un-terminated, where applicable, as spare

d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector

e. Manufacturer: Corning Cable Systems LLC, Model CCH-03U, or approved equal.

3. Each Type 2 Fiber Optic Patch Panel shall be as follows:

a. Mounting: 19" rack mountable, with necessary brackets. Refer to the CONTRACT DOCUMENTS

b. Capacity: Up to two (2) connector panels

c. Connector Panels:

1) Six (6) SC Duplex adapters of ceramic type.

2) Furnish and install connector panels as required to terminate all fiber strands of cables terminated to patch panel. Refer to CONTRACT DOCUMENTS.

3) Unused slots of patch panel shall be covered with blank panels.

4) Commence termination of panels from the left side of patch panel (when viewing front/user accessible side of panel), and leave right most panels un-terminated, where applicable, as spare

d. All unused fiber optic connector ports shall be covered with a dust

protector covering provided by manufacturer of connector

e. Manufacturer: Corning Cable Systems LLC, Model CCH-01U, or approved equal.

4. Each Type 3 Fiber Optic Patch Panel shall be as follows:

a. Mounting: Wall mounted with necessary mounting bracket kit and any additional accessories. Refer to the CONTRACT DOCUMENTS

b. Capacity: Up to six (6) connector panels

c. Connector Panels:

1) Six (6) SC Duplex adapters of ceramic type.

4) Commence termination of panels from the back side of patch panel (closet to back panel), and leave front most panels un-terminated, where applicable, as spare

d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector.

e. Manufacturer: Corning Cable Systems LLC, Model WCH-06P, or approved equal.

G. Fiber Optic Patch Cords:

1. General:

a. Use for indoor runs of fiber cable between a fiber optic device and a fiber optic patch panel, between adapters on the user side of two patch panels, or between two fiber optic devices

b. All fiber patch cords shall not consist of any splices of the fiber strands

c. Each fiber in each patch cord shall be placed in individual tight thermoplastic buffer tubes and protected with kevlar strength members and enclosed with a thermoplastic jacket with an outer diameter of at least 2.5mm

d. Each patch cord shall consist of at least two (2) fibers, according to the fiber count requirements of the communication devices the cable is interconnecting

e. Each patch cord shall be pre-connectorized with the appropriate type connector by the manufacturer

f. Provide length as required for the application

g. Patch cords shall be selected with connector ends to mate/match the

equipment/device/patch panel connector to which they interconnect. Duplex devices/patch panel connectors shall interconnect with duplex patch cords. Patch cord mode type shall be the same as that of device mode type and fiber patch panel connector connected fiber strand mode type with which patch cord is interconnecting

h. Patch cord connectors: connectors on each end of fiber optic patch cord shall mate/match that of the device/patch panel connector to which it is interconnecting on that respective end. All connectors shall have ceramic zirconia ferrule. All connecters shall be Ultra PC Polish. The connector mode type shall be the same as that of the fiber strand of the patch cord.

i. Manufacturer: Corning Cable Systems LLC, Model Zipcord cables, or approved equal.

PART III - EXECUTION

3.01 SHIPMENT AND STORAGE

A. Storage: Refer to Specification Section 17100

3.02 GENERAL INSTALLATION AND PANEL ASSEMBLY

A. The ICS shall furnish labor, materials, equipment, and incidentals required to install the system in accordance with specifications.

B. The ICS shall be responsible for ensuring that field wiring for power and signal circuits is correct and wired in accordance with best industry practice. Also, the ICS shall be responsible for providing all necessary system grounding to insure a satisfactory functioning installation.

3.03 FIBER OPTIC SYSTEM AND ETHERNET SYSTEM COPPER CABLING-SOURCE QUALITY CONTROL

A. Fiber Optic Splice-on Connector Termination:

1. The specified splice-on connectors shall be terminated using a fusion splicer and splicing oven with fiber holders to ensure the fiber cables are machine aligned prior to splicing. The splicing oven shall be the Fujikura 12S Fusion Splicer or approved equal. Splicer and oven shall be compatible with the splice-on connectors. The loss of the fusion splice shall be no greater than 0.1 dB.

B. Fiber Optic On-Site Testing:

1. General: The ICS shall provide all equipment, instrumentation, and supplies necessary to perform all testing. The OWNER/ENGINEER shall have the option to witness and participate actively in the On-Site tests

performed by the ICS firm.

2. Cables shall be tested with an Optical-Time-Domain Reflectometer "OTDR", as described hereinafter. The OTDR shall be designed to test the type of cable required for the project and shall include a laser light source used for transmitting test signals through the fiber under test. Contractor shall use launch cables of minimum length of 500 feet and tail cords (receiver cables) when performing testing with the OTDR. OTDR test wavelengths shall be as follows:

    a. Single-mode cable: 1310nm and 1550nm

    b. Multi-mode cable: 850nm and 1300nm

3. OTDR test results shall include the following, at minimum:

    a. Cable tested

    b. Fiber number

    c. Direction of test

    d. Wavelength

    e. Reference power reading,

    f. Total length of fiber

    g. Attenuation of the fiber

    h. Power loss (in dB) across the length of fiber cable. The results shall also show the individual numerical dB loss values of the loss across each connector, each splice, and each fiber cable.

    i. OTDR traces, legibly plotted. The traces shall be displayed on a trend chart with size 7" long and 5" high. The trace shown should be zoomed/scaled so that it spans the area of the displayed chart, and the vertically and horizontal axis labels adjusted accordingly.

    j. Additional information as necessary to determine insertion loss across the connectors and cables.

4. Pre-installation testing: Prior to the physical placement of the fiber optic cable, each fiber shall be OTDR tested onsite or at contractor's facilities, while on the spool. Submit test results for approval prior to cable installation.

5. Post-installation Testing:

    a. Separate OTDR tests shall be performed on all installed fibers (both used and unused fibers) as follows, with all test results submitted accordingly:

1) Cable after connectorization. Perform test from **both ends** of the cable, at each patch panel connector attached to the cable's fiber strands.

b. Fiber end-to-end attenuation testing

1) Fiber end-to-end attenuation testing shall be performed on all installed fibers (both used and unused fibers) after connectorization from both ends of the cable.

2) These tests shall utilize a stabilized light source and optical power meter. The attenuation tests shall be performed at wavelengths of 1310nm and 1550nm for Single-mode cable and 850nm and 1300nm for Multi-mode cable. Documented results to be provided shall include the cables tested, fiber number, direction of tests, wavelength, the power loss (in dB) across the length of fiber cables tested, and reference power reading.

c. Fiber device-to-device attenuation testing

1) This testing shall be performed after all necessary patch fiber patch cords have been installed in the system.

2) This test shall be performed on all renovated fiber optic links between fiber optic devices. The test shall be conducted only after all necessary patch cords to be used in the final system to create the link between devices are properly installed. The tests shall be performed from both ends of the link. The test should include all installed patch cords in the link, including the end patch cords that are to connect to the switches themselves.

3) These tests shall utilize a stabilized light source and optical power meter as well as OTDR. The attenuation tests shall be performed at wavelengths of 1310nm and 1550nm for Single-mode cable and 850nm and 1300nm for Multi-mode cable. Documented results to be provided shall include the cables tested, fiber number, direction of tests, wavelength, the power loss (in dB) across the length of fiber cables tested, and reference power reading and OTDR results, as identified in these specifications.

C. Copper Ethernet Cable System Testing:

1. After installation of Copper Ethernet Cable System, ICS shall perform testing of the cable system to assure compliance of the installed system with the TIA/EIA-568-C.2-10 Category 6A requirements. Testing shall be performed for all installed copper cable systems, including used and unused links, from end-to-end, including all data outlets, connectors, patch panels, patch cords, etc

2. Copper Ethernet Cable System Test reports shall be submitted to the engineer and owner for review and approval. The test report shall

document, for each copper data link, description of the link and components therein, the testing method used, test results, and demonstrate compliance with TIA/EIA-568-C.2-10 of the link. If any installed link does not meet the TIA/EIA-568-C.2-10 Category 6A requirements, ICS shall repair/modify link to assure it is compliant with TIA/EIA-568-C.2-10 Category 6A standard at no additional cost to the owner.

3.04 TESTING

A. Refer to Section 17100

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

3.06 WARRANTY

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents

B. Warrant equipment free of defects in material and workmanship for 2-years; cover parts and labor. Manufacturer's warranty shall be issued in the Owner's name.

PART IV - TRAINING

4.01 GENERAL

A. Provide a training program for the OWNER’s personnel to address all equipment provided. The training program shall meet the specific needs of the OWNER and include the following subjects, at a minimum:

1. Hardware

    a. Specific training for the actual hardware configuration provided

    b. Test, adjustment, calibration, troubleshooting, and component replacement procedures.

2. Software:

    a. Operate the equipment on a day-to-day basis.

    b. Make programming changes for all aspects of programming/configuration/functionality.

c. Configuration, troubleshooting, software installation procedures.

d. Assist the hardware maintenance technicians in diagnosing problems with the equipment.

e. Classes shall be designed for students having the equivalent of a one semester class on personal computers, but no professional programmable controller programming experience, OIU programming experience, or Ethernet switch configuration experience.

B. Additional training program requirements to be provided under the **Bid Allowance**:

1. Training duration:

a. Cisco Ethernet Switches/Routers: Provide a minimum of one (1) session.

1) Course Code: Implementing and Administering Cisco Solutions (CCNA) 1.0

a) Provide training by New Horizons Worldwide, Global Knowledge, or other approved Cisco Certified Learning Partner

C. Training Location: OWNER's designated facility located in Austin, Texas. Include all associated expenses.

D. Shift Quantity: Total of one shift, with a minimum ten (10) of the Owners personnel for each shift. Provide the training coordinated with the OWNER's schedule.

E. Personnel attending the training will be technical, managerial, administrative, engineers, and maintenance type personnel. The training shall accommodate instruction methods and materials accordingly.

END OF SECTION

PART I - GENERAL

1.01 DOCUMENT CONVENTIONS AND PURPOSE

A. The following terms, used throughout this document, shall be as defined below:

1. "Will", "shall" or "must" indicates a mandatory requirement or course of action.

2. "Should" indicates a recommended requirement or course of action

3. "May" or "can" indicates a possible course of action.

B. This document outlines the basic control philosophy for the Facility and describes the site process control requirements to be read in conjunction with the various mechanical equipment specification sections and referenced against the project Process and Instrumentation Drawings (P&IDs), electrical control schematics, specs and plans.

C. Any deviation from the requirements of this document must be approved in writing by the Engineer of record or authorized representative.

1.02 THE REQUIREMENT

A. **General:** The CONTRACTOR, through the use of a qualified and directly contracted System Integrator (ICS), shall be responsible for configuring and programming PLC and HMI hardware for implementation of the control philosophies described in this section, the functions detailed on the Contract drawings, and the points listed in the I/O schedule. The requirements of Specification Section 17100– Process Control and Instrumentation Systems (PICS) apply to this section. Vendor package suppliers, also under contract with CONTRACTOR, shall be subject to the same responsibilities and requirements (as further detailed in section 2.1).

B. PLC controller programs shall be capable of functioning normally in the absence of an HMI station without any special modifications. Process logic, including monitoring, control and alarming functions shall be programmed at the PLC controller level only. Vendor PLC-based control packages shall be subject to the same requirements.

C. Abbreviations used in this section:

A/M	Auto/Manual
AAH	Analyzer Alarm High
AAHH	Analyzer Alarm High-High
AAL	Analyzer Alarm Low
AALL	Analyzer Alarm Low-Low
ACK	Acknowledge
ATC	Automatic Transfer Controller

AWT	Advanced Water Treatment
CIP	Clean-In-Place
DCS	Distributed Control System
DLR	Device Level Ring
DOL	Direct On-Line (Starter)
FAL	Flow Alarm Low
FAH	Flow Alarm High
GUI	Graphic User Interface
HMI	Human Machine Interface
HOA	Hand-Off-Auto
HOR	Hand-Off-Remote
I/O	Input / Output
L/R	Local/Remote
LAH	Level Alarm High
LAHH	Level Alarm High-High
LAL	Level Alarm Low
LALL	Level Alarm Low-Low
LCP	Local Control Panel
LCS	Local Control Station
LO	Locked Out
LOA	Local-Off-Auto
LOR	Local-Off-Remote
MCC	Motor Control Center
MPRM	Motor Protection Relay Module
NAS	Network Attached Storage
NPW	Non Potable Water
NTP	Network Time Protocol
OCA	Open-Close-Auto
OI	Operator Interface
OSC	Open-Stop-Close
PAH	Pressure Alarm High
PAHH	Pressure Alarm High-High
PAL	Pressure Alarm Low
PALL	Pressure Alarm Low-Low
PD	Positive Displacement
PID	Proportional + Integral + Derivative
PLC	Programmable Logic Controller
RAS	Return Activated Sludge
RIO	Remote Input / Output
RVSS	Reduced Voltage Soft Starter
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating Procedure
S/S	Start/Stop
TAH	Temperature Alarm High
TAHH	Temperature Alarm High-High
TBC	To Be Confirmed (By the Engineer prior to or at the FAT)
TBD	To Be Determined (By the Engineer or Vendor during field commissioning)
UPS	Uninterruptible Power Supply
UW	Utility Water

VCP	Vendor Control Panel (Supplied by Equipment or Package Vendor)
VFD	Variable Frequency Drive
VSD	Variable Speed Drive (Integral to Metering Pumps)

D. The CONTRACTOR (and Vendor package suppliers) shall reference mechanical drawings and specification sections and electrical equipment location plans, specifications and control schematics as noted on the P&ID drawings for additional control clarifications.

PART II - PRODUCTS

2.01 THE CONTROL SYSTEM ARCHITECTURE

A. Required PLC controller and communication cabinets (as shown on the Network Block Diagrams) shall be furnished (configured, programmed and fully tested) by the ICS (under direct contract with the CONTRACTOR). PLC controller programming shall be as described herein. The PLC controllers shall be used to automatically monitor and control equipment provided under this contract. The PLC HMI hardware shown on the Network Block Diagrams shall be used to facilitate a GUI for the Facility system monitoring, operator setpoint entry, and operator interface to the Facility PLC control functions (inclusive of vendor package controls as defined herein).

B. Required package vendor PLC panels shall be factory-assembled, configured and programmed by the package vendor as described herein and elsewhere in the contract documents – all as confirmed by the Engineer in the certified vendor submittals. The vendor package PLCs (as specified in section 17600) shall be used to automatically monitor and control equipment provided in the associated vendor package. The vendor package HMI hardware specified in Section 17600 and shown on the Network Block Diagrams (where applicable) shall be used to facilitate a GUI for package system monitoring, operator setpoint entry, and operator interface to the package PLC control functions.

> Note: For networked vendor packages, the Vendor shall be subject to specific programming requirements to ensure that a parallel HMI interface to the Vendor PLC - Plant master HMI and the Vendor OI - can be properly managed without input handling conflict at the Vendor PLC.

C. The CONTRACTOR shall be responsible for field assembly, installation, pre-commissioning, final commissioning and startup of the control network components as detailed in the Contract Specifications.

D. System Overview:

1. The control system architecture, as shown on the network overview drawings, will be largely based on the Schneider Electric Modicon line of PLC processors. The Ethernet network will utilize single mode fiber optic cabling as the primary communication medium. The balance of plant controllers will be used to govern coordinated operation of the Vendor

package systems as well as provide control and monitoring of other non-Vendor supporting systems.

2. Major vendor control packages with single controllers will be entirely based on the Schneider Electric line of Modicon controllers with dedicated Harmony OIU (as developed by the package Vendor). The major vendor control panels will be field located on or in close proximity to the associated equipment skid, directly connected to the plant control network via industrial managed Ethernet switch.

3. All controller cabinets (CP01 and CP02) are intended to be normally (common) supplied with a non-key locked 3-point latching handles (pad-lock ready). By default, the status points listed below will be monitored for all panels and access to the controller IP webpage (as applicable) provided.

    a. Intrusion Detection

    b. High Temperature

    c. Failure of Primary Power Supply

    d. Failure of Secondary Power Supply

    e. Primary Controller Failure (inclusive of power supply)

    f. Secondary Controller Failure (inclusive of power supply) – where applicable

4. Normal operation of plant equipment will require the presence of an online plant and/or Vendor package controller. However, E-room equipment local controls will be provided to support maintenance activities or, in some cases (as identified in the detailed control philosophy sections) override emergency operation. Specifically, starters will include local controls at the starter; access to drive local control functions will be available but password protected; drive / starter local safety interlocks will be provided (as shown on the P&IDs and electrical control schematics) to support direct interface of hardwired mechanical protection signals.

5. To the fullest extent practical, variable speed drives will be interfaced to the CP01 PLC and Vendor CP02 PLC controllers using hardwired cabling (for control and monitoring). Status monitoring of UPS units (unless specifically noted otherwise), smart power monitors, motor protection relay modules and select process analyzers will be based on Modbus TCP protocol (using industrial stranded copper Cat6A cabling). Traditional hardwired copper connections will be used for monitoring of discrete field signals and control of on/off valves, starters and other equipment requiring a discrete control interface. Similarly, traditional shielded conductor pairs will be used for monitoring of analogue field signals and control of modulating valves and other equipment requiring an analogue

control / remote setpoint interface. Analogue signals of 4-20mA will be proportionally scaled to the measured or control value. Discrete signals will be 24VDC unless specifically noted otherwise. Instruments certified to be HART compatible shall be preferentially supplied.

6. Most plant equipment will include a field-mounted local control station (LCS).The LCS is intended to provide an Operator accessible emergency stop control point in close proximity to the associated equipment. The LCS push-pull E-stop button command signal will be directly fail-safe hardwired to the associated starter or drive (refer to project electrical control schematics).

2.02 PLC/HMI CONTROL FUNCTIONS

A. **General:** PLC/HMI requirements are as listed in the sub-sections below and are generally applicable to Vendor developed PLC/OI control packages except where specifically noted as "Not Applicable to Vendor Packages".

B. **Standards:** The ICS shall refer to the Austin Water Control System Programming Standards, attached as Appendix A. Where conflicts exist between the specification and AW standards, the AW requirements shall govern.

C. **Development Overview and Access:** The PLC HMI shall display the status or value of all PLC controller input and output points described in this section, detailed in the I/O schedule and shown on the P&ID drawings. In addition, the PLC HMI shall serve as a parallel interface point for all networked vendor package controllers, displaying the status or value of all shared I/O points as well as providing access to vendor package control points and setpoint entries. Unless specifically directed otherwise by the ENGINEER in writing, controller and OI / HMI control screen development requirements shall be subject to the requirements detailed herein and the following specification sections:

1. Section 17600 – PLCs and OIUs Equipment

2. Austin Water (AW) Control System Programming Standards

Access to the PLC HMI (and vendor control package OIs) will be password restricted to authorized personnel only with increasing authority required to effect system changes. In general, PLC HMI base access groups will be defined as follows:

1. Maintenance Group – view access to specific equipment usage / performance summary screens (with pre-defined historical and real-time trend pop-ups), alarm screens and Viewpoint Navigation screen. No other view, write or control access rights. Alarm acknowledgement will also be restricted.

2. Operations Group – typically granted equipment and process control rights but limited access to process control configuration / tuning parameters.

Specific operator adjustable values shall be as defined in the detailed control descriptions.

3. Supervisory Group – typically granted administrative level rights within the control system software environment but only limited (if any) access to the operating system. Supervisors shall have access to all operator adjustable values as well as process control configuration / tuning parameters and alarm configuration. Specific supervisor tunable values shall be as defined in the detailed control descriptions.

4. Administrator / Developer – full application and operating system level administrative access rights.

D. **Controller Setpoint Handling:**

Operator entered setpoints shall be constrained to match PLC programmed setpoint ranges. If a value lower than the setpoint range is entered, the PLC program defaults to the lowest possible range value. If a value higher than the setpoint range is entered, the PLC program defaults to the highest possible range value. The PLC shall prohibit entry of setpoint values beyond the operational range of a system or process. In general, confirmed PLC setpoint entries become the default program values. All system setpoints are to be made adjustable at the HMI by authorized users as detailed in the individual control philosophy sections.

Should a PLC reboot occur, through purpose or uncontrolled event, the PLC program shall be automatically restored with last setpoint entries. No operator intervention shall be necessary to bring a freshly rebooted controller online and operational.

E. **Controller Run Output handling:** In general, a PLC issued motor run command signal shall be propagated as a maintained contact. However, the PLC run command output signal must be disabled under the following conditions:

a. Equipment stop issued (by the PLC, operator or Local Auto logic).

b. Equipment fail detected.

c. Equipment placed in local control at the equipment, outside of PLC control.

d. Power-loss (black-out) condition detected.

If separate START and STOP (or Open and Close) outputs have been allowed for, once initiated, the PLC shall maintain the selected output for no less than 3 seconds to allow the local logic sufficient time to latch in the PLC issued command signal.

F. **Significant Digit Usage:** All HMI display values will be configured to show a minimum of 1 significant digit except in the following cases where 2 significant digits are required:

1. Flow readings (where the primary reading is scaled to 3 digits or less)

G. **Control Mode Definitions** – as a function of defining system control logic, it is necessary to define the manner and extent of control available at the major control access layers. Typical access layer control definitions are provided here as reference.

1. Local Control Mode (Field Selected): This mode of control refers to the first line of operator initiated control functions available at the equipment and/or drive/starter and by definition PLC independent. This mode of operation, although available in most cases, will be generally restricted to maintenance activities except where specifically noted otherwise.

2. Local Safety Interlocks: This level of control is not selectable and is always active. It specifically refers to protection hardwired logic integral to the equipment or equipment package that is directly interlocked with the equipment controls and which automatically executes regardless of the current method of operation.

3. Controller Programmed Safety Interlocks: This level of control is not selectable and is always active unless parameter bypass selection is required to be HMI accessible and then invoked by a Supervisor. It specifically refers to protection logic programmed at the PLC with an output that is directly hardwire interlocked with the equipment controls and which automatically executes regardless of the current method of operation. Note: The output will be wired fail-safe such that in the event of controller failure, the equipment will be forced to stop.

4. Local Auto Control Mode (HMI or Field Selected – subject to package configuration): This mode of control refers to independent operational logic integral to the equipment or equipment package that is responsible for the proper operation of the equipment. The operational logic may execute based on remote command triggers (e.g. start/stop, open/close, etc.) or field inputs (e.g. flow, pressure, level, temperature, etc.). Local auto mode may be bypassed through selection of local control mode (if available).

5. Remote Manual Control Mode (HMI Selected): This mode of control refers to operator initiated control functions available via the control system operator interface, HMI or LCP but executed via the PLC control logic (i.e., all PLC process interlocks and safety functions remain engaged).

6. Remote Auto Control Mode (HMI Selected): This mode of control refers to PLC initiated control functions which are automatically executed and managed by the PLC logic, operator independent.

7. Other control modes applicable to a specific process or system shall be as defined in Part 3.

H. **Historical Data Collection and Display:** The existing plant Historian shall be used to historically collect, trend and record, in the historical database, all analog input and output data represented on the Contract Drawings and I/O Schedule. In addition the HMI shall:

1. Log (daily and lifetime) runtimes to the historical database for all monitored equipment.

2. Log the number of starts to the historical database for all monitored equipment.

3. Calculate and log daily (and other Part 3 required) flow totals for all measured flows.

Note: daily flow totals will be summed and recorded over a 24-hr period from 12am to 12am with allowance for daylight savings time (DST) annual time shift.

I. **Trending Format – General:** As a minimum, trends shall display the process variable, the transmitter tag, a clear description and the units for both axes. For variables which are controlled by the PLC, both the setpoint and the controlled process variable shall be displayed on the same trend. Where multiple variables are displayed, separate and distinct colors shall be used for each variable along with a color key with clear descriptions defining each variable. The ICS shall be responsible for providing PLC programming to support the above log points. All logic required to develop the above I/O for historical collection at the HMI shall be provided by the System Integrator.

J. **Alarm Terminology:** The following alarm terms will be used throughout this document.

1. Permissive: PLC tracked Input, status, interlock and/or process variable value required to allow start of a piece of equipment or a process to proceed. Although lack of permissive will inhibit start, loss of permissive will not necessarily generate a fault once the equipment or process is operational.

2. Warning or System Alert (displayed as per Owner graphics standards): PLC generated low priority alarm intended to alert Operators to process or equipment operation drift outside of norm. Typically the gap between "warning" and "alarm" is sufficient to allow Operator response to avoid an alarm/trip condition.

Note 1: System alerts are also utilized at specific field equipment locations to alert area personnel to imminent start of rotating equipment. System alerts (typically in the form of beacons and/or horns) are only used in areas of potentially unsecured (i.e. exposed

and/or approachable) rotating equipment which may start unexpectedly.

3. Alarm or Trip (displayed as per Owner graphics standards) PLC generated high priority alarm or interlock intended to alert Operations to PLC execution of equipment or process protective measures OR imminent fault condition requiring operator intervention / action.

K. **Alarm History:** The project's alarm history (inclusive of system warnings, alarms and advisories) shall be made accessible at the HMI to all authorized users. The Alarm History shall be established as read-only from the moment of system field initialization. An alarm configuration screen at the HMI shall allow a Admin to enable or disable any HMI warning or alarm notification without the need to access the control system software back office tools. Other related requirements:

1. Warnings / Alarms related to HMI displayed field equipment and facilities shall be displayed on the related system control screen as well as recorded in the historical alarm summary.

2. Warnings / Alarms may be assigned to one of four (maximum) sub-groups. The alarm sub-groups shall be as defined at the conclusion of the project Graphics Meetings.

L. **Fault Detection / Handling:**

1. Unresponsive Equipment: In addition to monitoring fail contacts for controlled equipment, if at any point a device fails to start, stop, open or close as commanded by the PLC, a "Fail to Respond" condition shall be generated by the PLC and displayed at the HMI. PLC generated "Fail to Respond" fault, as well as any other logically generated fail condition identified in the detailed control philosophy sections, shall be resettable at the HMI unless specifically noted otherwise. The HMI reset function shall be in the form of a screen button made visible to the Operator at the interlock or control faceplate when a PLC generated fault condition is detected for the associated equipment. "Fail to Respond" specifics shall be as follows:

   a. When a drive or starter is being called to run, default "Fail to Respond" fault delay shall be 10sec. If a drive or starter is called to start and run status is not received before expiration of the fault timer (Supervisor adjustable), the controller shall generate a "Fail-to-Respond" alarm and lock-out the equipment.

      1) In general, the "Fail to Respond" time delay timers (for stop commands in particular) will take into account the drive configured spin-down timer.

   b. When a drive or starter is in operation, if the run status is lost for longer than 3secs (Supervisor adjustable), the controller shall generate a "Fail-to-Respond" alarm and lock-out the equipment.

c. In both cases, only an HMI reset will be required to allow the equipment to be restarted.

2. Analogue Inputs: The PLC shall generate an instrument or signal fault (Out of Range or PV_Bad) alarm if the analog input from a given field instrument or device is detected to be equal to or less than 3.8mA or equal to or greater than 20.5mA for longer than 10 seconds. The alarm time delay assigned to each signal shall be a Supervisor adjustable value.

   Note: When an instrument is detected to be in fault, system control response to the signal and all associated alarms (e.g. LAHH, LALL, etc.) shall be suspended. Other system response specifics shall be as defined in the Part 3 control detailed control descriptions.

3. Discrete Instrument Warning / Alarm Contacts: The PLC shall process a discrete warning / alarm contact if the contact is detected to be active for longer than a preset (supervisor adjustable) time delay. The default settings shall be 2 seconds unless specifically noted otherwise in the Part 3 detailed control descriptions.

   Note: discrete signals arriving via drive, starter, actuator, LCP or other device which have already confirmed authenticity of the alarm shall be immediately processed by the PLC without time delay unless specifically noted otherwise in the Part 3 detailed control descriptions

M. **Event Logging:** An event log, separate from the alarm history, shall be made accessible at the HMI (read-only from the moment of system field initialization) to all authorized users. The event log shall date/time stamp and record any discrete change in status of the equipment monitored by the PLC (e.g., Auto/Manual, Local/Remote, Run/Off, Open/Close, Forward-Off-Reverse, Intrusion, Start Sequence Change, Alarm Enable/Disable, etc.). Important notes:

1. HMI adjustable setpoint values shall be historically collected and trended against the associated process variable or performance parameter.

2. Events may be assigned to one of four (maximum) sub-groups. The event sub-groups shall be as defined at the conclusion of the project Graphics Meetings.

N. **Loop tuning parameters:** The PLC HMI interface shall be configured to allow supervisory level users to access all loop tuning parameters from the HMI for any control loop. Changing loop tuning parameters shall not require reconfiguring, reprogramming, or reloading of the PLC program. All changes to any loop tuning parameters shall be logged to the historical database and trended as described under paragraph 2.3.L – Event Logging.

O. **Equipment READY Logic:** The term "READY" (used throughout this document) shall be interpreted as "being available for PLC control". The

following conditions, as applicable, must be satisfied to achieve "READY" status:

1. Field equipment is Available (powered) AND is currently in Remote and/or Auto mode at the starter/drive/actuator (as applicable) i.e. not in Local Control Mode.

2. No fail (interlock) conditions pending (including field E-Stop).

3. No run inhibit (permissive) conditions exist.

    a. Equipment start via the PLC cannot be achieved without the associated equipment satisfying the above "READY" definition. With initiation via the PLC and run status confirmation, the equipment shall be noted to be in REM AUTO RUN or REM MAN RUN mode depending upon HMI operating mode selection.

        1) Note: if the equipment has been started at the starter/drive control interface, the equipment shall be noted to be in LOCAL RUN mode with PLC confirmation of run status

4. Unless specifically stated otherwise in the detailed control descriptions, it will not be necessary to display a "Not Ready" status if the above conditions are not satisfied. However, fail conditions, run inhibit conditions, local control status and run status shall be clearly displayed.

P. **Local Control Station (LCS) Handling Reference:** Where shown on the contract drawings, a local control station shall be provided at the field equipment. Each station shall include one push-pull E-Stop button fail-safe hardwired directly to the starter or drive and which may be engaged with effect regardless of the current operating mode of the equipment or communication means (hardware or fieldbus). Once pressed, the equipment will be immediately disabled at the starter / drive local control level and an alarm generated at the HMI. Release of the LCS E-stop button and reset of the alarm condition at the drive and the HMI will cancel the emergency stop.

Q. **Process Control Deviation:** Throughout the various plant processes, the PLC will be required to control and manipulate equipment designed to maintain a preset flow, level, temperature, pressure or other water quality parameter. In general, should the control system fail to maintain the identified process parameter within the operator or system specified deadband for longer than a preset time period (Supervisor adjustable default shall be as nominated within the specific control section and/or the project alarm table), a process warning shall be generated by the PLC and displayed at the HMI. In specific instances (as defined in the Part 3 detailed control descriptions), should the condition persist beyond a second preset time delay, a critical process alarm shall be generated. Additional system response shall be as defined in the specific control section.

R. **VFD Control Coordination:** In general, VFD operating parameters critical to proper drive operation will be established at the drive. The PLC control program will be developed to support this arrangement.

1. Where a start delay timer has been set at the pump VFD, the PLC shall be programmed to account for pump start delay in the re-start logic (and fail-to-respond logic) following issue of pump stop command or unexpected pump stop. Where possible the start delay timer shall be displayed at the HMI.

2. It should be anticipated that the VFD of any given pump may include a custom configuration that does not necessarily support operation over the entire speed range. The PLC speed control signal (as generated by logic controller or operator entered setpoint) shall be ranged 0 to 100% of maximum and output proportionally from 4-20 mA. The VFD will manage the received signal over its actual configured operating range.

3. For all VFDs, the ramp rate (starting and stopping) shall be as set at the VFD. The PLC PID controller (as applicable) will be tuned to take into account the final VFD ramp rate.

S. **Auto Rotation Logic:** Where referenced in the detailed controls section, the start sequence for a system of pumps or other equipment may be automatically established by the PLC or manually established by an authorized Operator.

1. PLC Auto Sequencing: In auto sequencing mode, the equipment start sequence will be automatically rotated by the PLC based on runtime values. Pump runtimes will be continuously compared. Should two or more runtime meters register runtime hours within a +/- 1hr deadband (Supervisor adjustable), the runtimes will be considered equal and the auto start sequence will default to the numerical order of the equipment in question (i.e. Pump No.1 will be selected to precede Pump No.2 under this runtime comparison scenario). When pump runtimes exceed the deadband limit, the start sequence will be automatically updated. However, pump operation will not normally be impacted by a start sequence change (in Auto or Manual sequencing mode): pump start/stop re-order will be applied as a normal function of pump Cascade start/stop operation unless specifically noted otherwise in the Part 3 detailed control descriptions. Auto PLC rotation may also be suspended by an authorized Operator via the HMI and the pump start sequence manually selected by the operator by means of an HMI pump start selection matrix.

    a. Override Auto Sequencing Runtime Comparator: An override sequencing runtime comparator will be provided and made adjustable by authorized Operator (default = 72hrs). Under auto sequencing mode, should the pump(s) remain in continuous operation for a period greater than the preset runtime comparator, the controller logic will auto cycle the pumps to match the current pending start sequence. For forced rotation, the new pump will

always be started and confirmed running prior to shutdown of the current in-operation pump (unless specifically noted otherwise in the Part 3 detailed control descriptions).

2. Operator Manual Sequencing: An authorized operator may manually establish the start sequence for a system of equipment by means of a matrix selection chart at the associated system HMI control screen. For manual start sequence entry, the operator will be required to enter a start position next to each equipment number. The selection interface will be programmed with a means of directing the PLC to accept or cancel the entered start sequence. Once the Operator has completed the start sequence, the PLC must be directed to accept the sequence in order for the entries to be written to the appropriate active PLC registers. Directing the PLC to cancel will clear all proposed entries. Submitted start sequences containing duplicate and/or invalid entries will be automatically rejected and not written to the active PLC registers (thereby retaining the original start sequence). Until the start sequence modifications are accepted, the PLC will ignore all unaccepted start sequence modifications and continue to operate equipment based on the current start sequence.

T. **Bumpless Remote Auto to Remote Manual Transition:** Changing the HMI control status of PLC controlled equipment from Remote Auto to Remote Manual shall be a bumpless operation. Therefore a VFD operating in Auto mode at 78% of maximum speed shall maintain that speed and remain in operation when switched from Auto to Manual control at the HMI. A similar adjustment to a modulating valve actuator should display identical behavior.

U. **Flow Signal Dampening:** Various flow meters are used to measure the rate of flow of water, air and chemicals throughout the facility. The PLC shall be programmed to dampen the incoming analog signal. This shall be accomplished by calculating a running average of the flow signal over 5-second periods (nominal setpoint) using a data sample rate of 0.5 seconds. The means for a supervisor to enable/disable this function and adjust the sampling period (fixed options of 5-sec, 10-sec and 15-sec) at the HMI shall be provided. Refer to individual Appendix sections for specific application.

V. **Out of Service:** The control system shall have the capability to assign an "Out-of Service" tag to equipment monitored by the control system. During extended periods of maintenance and/or repair, an operator may make such an assignment so as to suppress associated alarms and inhibit HMI control functions.

Note: normal "lockout / tag-out / check-out" procedures will need to be followed with the field equipment and associated electrical feeds.

W. **Control System Historian:** The ICS shall coordinate integration of project signals into the existing Proficy Historian, project alarms into the existing alarm management tools, and project events into the existing event log with the Owner. Data integration into existing Report generation tools is excluded. Creation of custom fixed trends is excluded.

X. **Control Philosophy Refinement:** It shall be understood that some refinement and/or minor modification of the control philosophy will be necessary over the course of the project as part of the control system configuration and programming work. Forums for informal discussions and clarifications have been provided in these documents. They include the Pre-submittal Conference, Graphics Development Workshops, Factory Testing, Field Development Phase and Startup. **Note:** All timer, level, position, analysis, pressure, temperature and flow rate values noted within the control philosophy sections are provided for reference only and are subject to refinement based on system testing and final construction.

1. Where the control philosophy sections reference control screens to be developed, final control screen development will be subject to the requirements of the Owner and the production agreements reached during the project Graphics Development workshops.

2.03 GRAPHICS GENERATION

A. It is the responsibility of the ICS to configure the OIU and to develop, design, engineer, configure and test all of the HMI graphic displays required for this project. All of this work shall take into account the specific needs and requirements of the OWNER. In order to facilitate this work the CONTRACTOR shall conduct the following meetings with the Engineer and OWNER's groups:

B. Graphics Meeting No. 1

1. The CONTRACTOR shall chair and develop an agenda for a meeting which shall address the basic criteria to be adhered to in the configuration and development of the HMI graphic displays. At this meeting, which shall be attended by the System Integrator, the Vendor, the OWNER and ENGINEER, the ICS shall present the OWNER's HMI standards and requirements for messaging, tagging, conveyance of screen updates and overall look of the Vendor OIT screens. As a minimum, this meeting shall address the following issues:

a. All facility conventions for identifying tag names and descriptors (this will include process areas, piping, mechanical equipment, tanks, valves, inline equipment, instruments, workstations/servers, control components and network components)

b. Designation of groups within each plant or station area along with tag names and descriptors.

c. The assignment of individual control loops and inputs to specific groups.

d. Organization of the systems universal display hierarchy.

e. Paging schemes to be used to enable the movement from one

display to another.

f. An itemization of the type of display to be used at each level in the graphic hierarchy (e.g., pre-formatted displays, templates, custom graphics, etc.)

g. Color convention to be employed on all graphics for the annotation of various status information, differentiation between alarms on the basis of alarm priority, background colors, static field colorization and dynamic field colorization.

h. The utilization of blinking and conditional text.

i. Definition of graphic symbolism to be used on the project. This listing shall include but not be limited to symbols to be used for process instrumentation, process equipment, piping, vessels and valves. All symbolism must be specific as opposed to generic in that shapes must define both function and type (e.g., specific symbols for each valve design, each pump design, each type of flow meter, etc.). If the CONTRACTOR's library of shapes does not adequately describe plant or pipeline conditions, the CONTRACTOR shall develop additional shapes to meet the plants or pipelines requirements.

j. Definition of all display select commands that enable the operator to move within the display hierarchy.

k. The utilization of cursor movement commands which enable the operator to move within a display.

l. Definition of control input commands which enable the operator to interact with faceplates control stations and custom graphic displays to implement control outputs/functions.

m. Definition of data input commands which enable the operator to enter numeric values into the PLC system.

n. Definition of the utilization of "poke" points or fields which are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.

o. A review of graphic generation procedures.

p. Historian data collection parameters.

q. Electronic O&M production and accessibility at the existing SCADA servers.

r. User groups and process monitoring/control accessibility

s. Overall system navigation and access philosophy and organization of screen monitoring and control data to support.

t. Vendor package control mode coordination – to manage control authority transition from a Vendor package OIT to the Plant HMI and vice versa.

u. Alarm handling, event logging and approach to managing historical alarm and event log access

v. Web-enabled devices web page integration.

2. Subsequent to the adjournment of graphics meeting No. 1 the CONTRACTOR shall collect from ICS prepare and formalize a document titled "GRAPHICS CRITERIA" which shall contain detailed meeting minutes and a definition of all graphic guidelines to be adhered to. This report shall be supplemented by a first draft OIT control screen package which illustrates the incorporation and application of each graphic criteria. The report shall be submitted to the ENGINEER for review / approval within 30 calendar days of the meeting's adjournment. ENGINEER comments will be returned to the CONTRACTOR for action and response review during Graphics Workshop No.2. A formal submittal shall be submitted prior to the second Graphics Workshop.

C. Graphics Meeting No. 2

1. After the finalization of the vendor graphics criteria, the CONTRACTOR shall develop a second draft HMI control screen package as required to support all vendor OITs being furnished under this project, taking into account the ENGINEER's first draft review comments. At this meeting the CONTRACTOR shall submit 5 color hard copies of the complete package and present a navigable version of the OIT control screen package using the project OIT software. During the workshop, the CONTRACTOR will:

a. Review the recorded requirements of Graphics Coordination Workshop No.1 and show how each has been addressed

b. Review the ENGINEER's and System Integrator's first draft submittal review comments and show or explain how each has been (or will be) addressed.

c. Review the OIT control screen package for overall content completeness

d. Demonstrate approach to input command handling, setpoint management and secure access control.

e. Demonstrate navigability, functionality and overall quality of delivery.

f. Collect and record all actionable comments received.

2. Subsequent to the adjournment of Graphics Coordination meeting No. 2 the CONTRACTOR shall prepare a formalized re-submittal (if necessary) of the OIT control screen package for ENGINEER review/approval along with the detailed meeting minutes. Meeting minutes shall be submitted within 5 working days of meeting adjournment and will include an expected time frame for CONTRACTOR delivery of the HMI control screen package re-submittal.

   a. The CONTRACTOR shall allow 1 day for each meeting.

3. The following HMI graphic displays shall be developed for this project (as minimum):

   a. All plant or station processes.

   b. All group alarm displays.

   c. All control loop tuning displays.

   d. All analog faceplate displays.

   e. All key macro icon displays.

   f. All database archiving control displays.

   g. All customer displays for operator set point entry and recipe displays.

   h. All historical trending displays.

   i. Control system network configuration and diagnostic displays.

   j. Redundant communication diagnostic and control displays.

   k. Redundant master node diagnostic and control displays.

   l. All local node diagnostics (include PLC's, Operator Interfacing Units and Instruments).

   m. All group event displays

D. Software License and Registration:

1. All software provided shall be installed and used within the terms of the software manufacturer’s license agreement. All software purchased by the

CONTRACTOR shall be registered to the CONTRACTOR during the construction phase of this project. During that time, the CONTRACTOR shall be responsible for providing and incorporating minor software package updates issued by the software manufacturer. For example, if version 3.1 of a program is purchased, and versions 3.2 and 3.3 were released prior to project completion, the CONTRACTOR shall be responsible for incorporating these later versions into the final project. The CONTRACTOR would not be responsible for incorporating major software revisions such as the release of a version 4.0 or 4.1.

2. Prior to substantial completion of this project, the CONTRACTOR shall re-register all provided software packages to the OWNER and provide the ENGINEER and the OWNER with written confirmation of having done so.

3. HMI Software shall be GE iFIX

PART III - EXECUTION

3.01 DETAILED CONTROL PHILOSOPHY SECTIONS

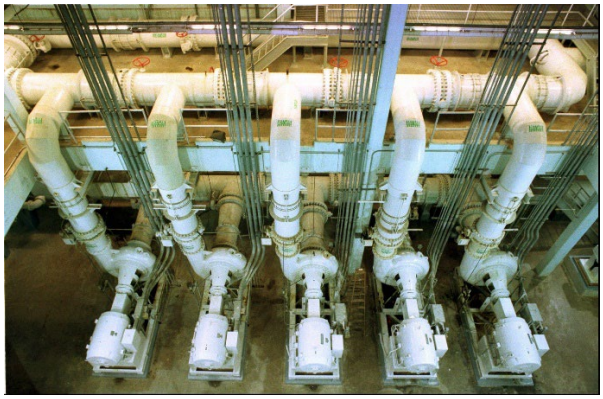
A. The listed detailed control philosophy sections shall be developed in accordance with Parts 1 and 2 of this specification. The sections are provided as appendices to this specification with the indicated CP-XX reference.

END OF SECTION

Austin Water Control System Programming Standards











Version History

Version	Date	Author	Description
100% Submittal	2021/02/26	E. A. Murphy H.S. Li	Originally written
001	2024/08/27	R. Straw J. Pressly	Expand AW_Library for use in all SCADA control systems (formerly water distribution control systems only). Add PLC Setup preferences, based on experience. Clarify operator station types and use of Vijeo projects for groups of OIU's. Emphasize that multiple PLC languages can be used, not only function block diagrams. Exclude a section for the INFOR / EAM Guide, refer it as a separate, standalone document.
002	2024/09/16	J.Pressly	Updated field alarm descriptions to clarify defined function block behavior relative to hardwired alarms, not detectable in the PLC. Affected AW_MODGATE, AW_MODVLV, AW_MOTOR, AW_VALVE and AW_VFD.

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Section 1: Introduction

1.1 General

1.1.1 Purpose

The purpose of this document is to establish the standards for implementation of Austin Water control systems. The programming standards shall provide uniformity in configuration methods among projects. This will be accomplished through use of software templates and best / required practices.

Previous versions of the guide targeted only water distribution and collection process controls. This version broadens the scope to include all types of treatment and distribution sites supported by the Austin Water SCADA Division, e.g., water treatment plants, wastewater treatment plants, packaged plants, lift stations, pump stations and reservoir sites.

1.2 Summary

The Programming Standards document includes the following sections:

- Section 1 – Introduction
- Section 2 – Definitions and Abbreviations
- Section 3 – Equipment Naming Convention
- Section 4 – PLC Configuration and Programming
- Section 5 – Operator station Programming
- Appendix A –Tag Name Descriptor and Qualifier Tables
- Appendix B – Defined Function Block Library
- Appendix C – OIU PLC Time Sync Method
- Appendix D – PLC Setup Preferences

1.3 PLC and Operator Interface Programming Software

Schneider Electric's EcoStruxure Control Expert software shall be used to develop all PLCs. GE Proficy iFIX is used for Windows PC-based operator interfaces, typically used in treatment plants. Schneider Electric's Vijeo Designer software shall be used for

programming and configuration of non-PC-based operator interface units (OIU's). Schneider Telvent OaSysDNA is used for water distribution and wastewater collection systems as the operator interfaces. *The control system programmer shall verify all software versions, including service pack number, with the Austin Water SCADA Division prior to program development.*

1.4 INFOR EAM Design Guide

The Austin Water Infrastructure Management Division (IMD) governs equipment definitions and equipment tag naming conventions for all of the City's assets. Their reference document, the INFOR EAM 11.4 Design Guide is available upon request.

Section 2: Definitions and Abbreviations

2.1 Definitions

These Programming Standards make use of the definitions shown in Table 1.

Table 1 Definitions

Term	Definition
Control Expert	Schneider Electric's EcoStruxure Control Expert software for PLC programming. In this document, the programming software will typically be referred to simply as Control Expert.
Harmony	A family of HMI touch devices manufactured by Schneider Electric. Formerly known as Magelis. Vijeo Designer is its configuration software.
Host	SCADA server for a water treatment facility or an entire telemetry system (see LSTS, WDCS).
Position ID	Position IDs provide department or site, process (area), and system to identify location and type of equipment at an Austin Water site. Used in a computerized asset management system. See also the Austin Water INFOR EAM 11.4 Design Guide.
Programmer	The Engineer or Contractor contracted with Austin Water SCADA Division to provide control programming services.
SubComponent	Appended to position ID in order to identify ancillary equipment, such as a control panel. See the Austin Water INFOR EAM 11.4 Design Guide.
Telemetry	A process using an electrical apparatus for measuring a quantity (such as pressure, speed, or temperature) and transmitting the result especially by radio to a distant station
Unity	Schneider Modicon programming software that preceded Control Expert. Programs developed using Unity software are compatible with Control Expert software. This is beneficial during upgrade projects. Unity is referenced in the installation instructions for the function block library templates.
Concept	Schneider Modicon programming software that preceded Unity. Programs developed using Concept software are not compatible with Control Expert Software.

2.2 Abbreviations

These Programming Standards make use of the abbreviations shown in Table 2.

Table 2 Abbreviations

Abbreviation	Description
AW	Austin Water, one of the utilities within the City of Austin, Texas
COS	Change Of State
CP	Control Panel
DFB	Defined Function Block. A customized programming block in Control Expert
EAM	Enterprise Asset Management
HMI	Human Machine Interface – generic name for operator console / process window.
I/O	PLC field inputs and outputs
LSTS	Lift Station Telemetry System. Consists of the top end system, network, facility PLCs, and facility instruments and controls.
MCC	Motor Control Center
NTP	Network Time Protocol
OIU	Operator Interface Unit. Typically, an industrial hardened touch screen graphical unit that is used for local area operations.
OWS	PC-based operator workstation, typically Windows PC running iFIX software for plant operations, running Telvent OaSysDNA for telemetry systems remote terminal units (RTUs).
PLC	Programmable Logic Controller
PSR	Pump Station and Reservoir site within a water distribution system
SCADA	Supervisory Control and Data Acquisition
X80	A Schneider Modicon platform common to Quantum Ethernet I/O, M340 PAC and M580 ePAC systems, such as backplane, power supply, I/O digital, I/O analog, communication modules.
WDCS	Water Distribution Control System, a telemetry system for remote sites. Consists of the top end system, network, facility PLCs, and facility instruments and controls.
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

Section 3: Equipment Naming Convention

3.1 Equipment Naming Convention

The Austin Water INFOR EAM 11.4 Design Guide designates naming rules for various types of equipment, including control panels. Major process mechanical equipment will have Position IDs, while control panels will have Subcomponent tags.

Examples of major equipment assets with Position ID's include process air blower, centrifuge, pump, reservoir, tank, and select, regulatory instruments and devices, such as a flow meter. Ancillary equipment that is associated with a Position is considered a Subcomponent. While the INFOR EAM does not provide detailed naming rules below the Subcomponent level, the AW SCADA Division has guidelines for PLC's, OIU's and other control and networking equipment. Examples will be provided in later sections of this document.

3.1.1 Position and Subcomponent Equipment - PSR

Position Equipment and Subcomponent Equipment are depicted in Figure 1.

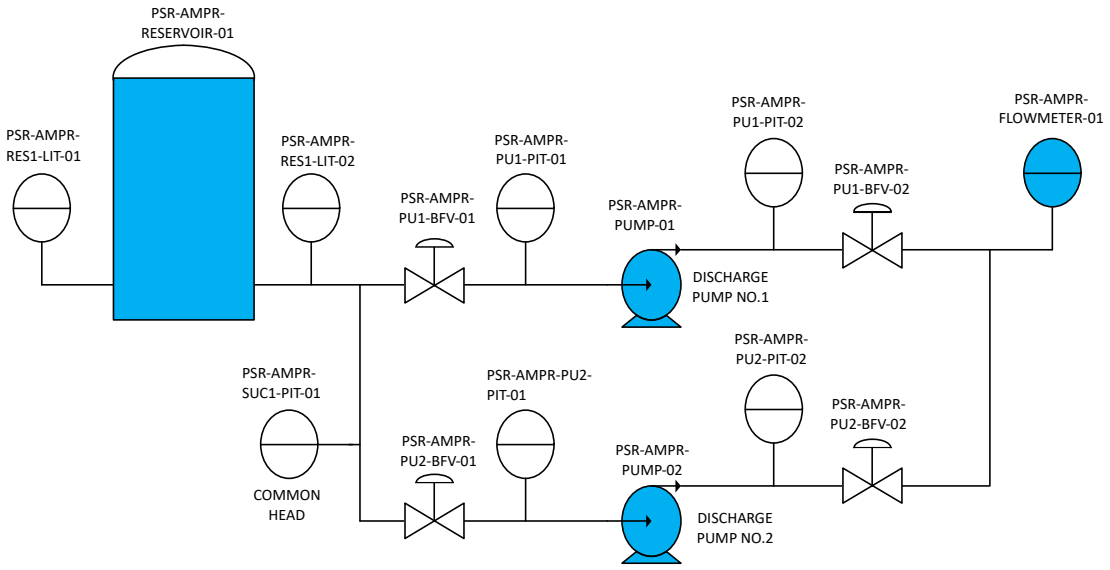


Figure 1 Equipment Typical of a Pump Station and Reservoir (PSR) Site

In this example diagram, Positions are represented by blue symbols, e.g., reservoir, discharge pumps and discharge flow. All other equipment items are Subcomponents.

3.2 Position Equipment Tag Naming Convention

In the asset management system, the tag name format for Position Equipment is:

Facility Code - Area Code - Position Code - Position Number - Descriptor Code - Qualifier Code

Example: North Anderson Mill Pump Station Pump No. 1 “running”

The pump status tag name is: PSR-AMPR-PUMP-01-RUNN-HI, where each part of the Position Equipment tag name is defined in Table 3.

Table 3 Position Equipment Tag Naming Convention Index

Code Type	Value	Reference
Facility Code	PSR	INFOR EAM Page 5
Area Code	AMPR	INFOR EAM Page 52
Position Code	PUMP	INFOR EAM Page 11
Position Number	01	Select from 01-99
Descriptor Code	RUNN	Appendix A
Qualifier Code	HI	Appendix A

The Austin Water INFOR EAM system specifies the top levels only, down to Position Code and Subcomponent Type. Descriptor Code and Qualifier Code are specific fields used for tag parameters in the AW SCADA control systems. Sample Descriptor Codes and Qualifier Codes are provided in Appendix A.

3.3 Subcomponent Equipment Tag Naming Convention

Subcomponent Equipment tag statuses use the following tag naming convention:

Facility Code or Area Code - Position Code Abbreviation - Position Number - Subcomponent Type - Number - Descriptor Code - Qualifier Code

Remote site tag names typically begin with the Facility Code, while Treatment Plant tags will begin with the Area Code.

Example: North Anderson Mill Pump Station Pump 1 Discharge Valve 1 Open

Subcomponent Equipment Tag name: PSR-AMPR-PU1-BFV-01-OPEN-HI, where the following categories apply:

Table 4 Subcomponent Equipment Tag Naming Convention Index

Code Type	Value	Reference
Facility Code	PSR	INFOR EAM Page 5
Area Code	AMPR	INFOR EAM Page 52
Position Code Abbreviation	PU	INFOR EAM Page 158
Position Number	1	Select from 1-99
Subcomponent Type	BFV	INFOR EAM Page 157
Number	01	Select from 01-99
Descriptor Code	OPEN	Appendix A
Qualifier Code	HI	Appendix A

Note: INFOR EAM Design Guide Page numbers are subject to change.

Section 4: PLC Configuration and Programming

4.1 General

4.1.1PLC Naming Convention

The PLC program file shall be named to match the PLC tag where feasible. The PLC name follows this convention:

Facility Code-Area Code-“CP”(Control Panel Number)-“PLC”-(PLC Number)

Note: Control panels preferably have CP designation for SCADA equipment. However, Main control panels use MCP and other process areas sometimes use another qualifier such as Blower Control Panel (BCP).

Example: South Austin Regional Dechlorination PLC

The PLC Name, as well as the PLC File and Project names all are SAR-DCL-CP1-PLC-01. The naming rule references are shown in Table 5.

Table 5 PLC Naming Example

Code Type	Value	Reference
Facility Code	SAR	INFOR EAM Page 5
Area Code	DCL	INFOR EAM Page 134
Position Code	CP	INFOR EAM Page 158
Number Abbreviation	1	Select from 01-99
Subcomponent Type	PLC	INFOR EAM Page 176
Number	01	Select from 01-99

Omit the facility code from the PLC reference tag name to be used in the programming software project, and in the iFIX Modbus to Ethernet (MBE) Power Tool. For this example, the PLC reference tag becomes DCL-CP1-PLC-01.

Figure 2 shows the project browser of Control Expert with a typical PLC name, and the corresponding X80 controller with a rack extension.

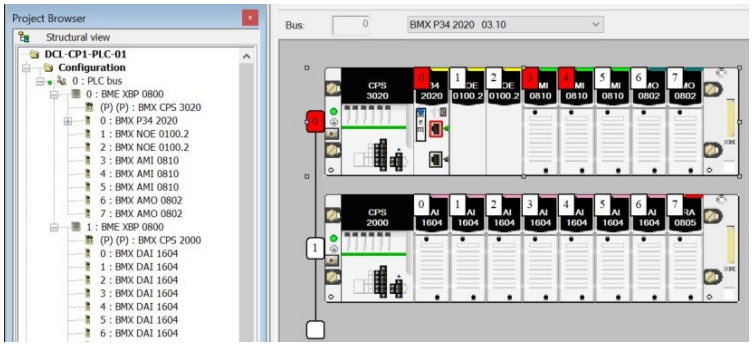


Figure 2 Control Expert PLC Project Browser with Rack Extension

4.1.2PLC Backup File Type

Password protection is PROHIBITED for PLC programs, including full project and any section thereof.

PLC programs submitted to the Austin Water SCADA Division shall be Archive files (.STA) file format.

4.2 PLC Configuration

4.2.1 Project Name

In the Control Expert PLC Program, at the top of the project browser, the project name shall be changed to the PLC name, defined in 4.1.1.

In the following example, the PLC and PLC project or program names are the same:

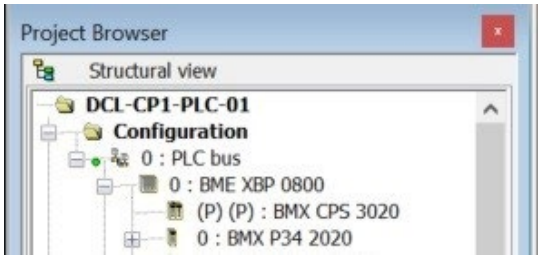


Figure 3 Project Browser with PLC Project Name

4.2.2 PLC Setup

The Austin Water SCADA preferred setup of Schneider Modicon M580 and M340 PLCs is detailed in Appendix D. Examples of preferences include setting the CPU ethernet port to an address for the PLC local device network, addressing ethernet modules for the SCADA top end A

and B networks, setting up NTP to synchronize the PLC clock with a time server, and settings that enable online changes without stopping the CPU for a full program download.

4.3 Programming Standards

4.3.1 PLC Programming Languages

Programming preferences include using function block diagram, ladder logic and structured text languages.

4.3.2 Standard Defined Function Blocks

Defined function blocks are *customized* function blocks. The AW_FAMILY DFB library covers most of the Austin Water equipment control tasks that require function block programming. The control system Programmer will utilize this library for PLC program development. It is available upon request from the Austin Water SCADA Division.

If the control system Programmer has to develop their own DFB for a special program task that is not provided in the standard DFB library, notify the Austin Water SCADA Division, and provide a submittal for Austin Water SCADA Division's approval. The submittal shall include DFB instructions and test results.

Refer to Appendix B for the AW_LIBRARY of Standard Defined Function Blocks.

4.4 PLC Programming Basic Requirements

4.4.2 PLC Raw Inputs and Raw Outputs

Raw I/O points shall not be used to program control logic in the PLC program. The raw I/O (%I, %IW, %Q, %QW) shall be conditioned and mapped with the appropriate function blocks in the AW_FAMILY library.

4.4.3 Analog Inputs and Outputs Conversion

All analog inputs and outputs will be scaled to engineering units in the PLC, not on the top end. Typical count ranges include and are not limited to the following:

AI Type	Range Low	Range High
4-20mA	4,000	20,000
0-20mA	0	20,000
0-10V	0	10,000
0-5V	0	5,000
-10 to 10V	-10000	10,000

4.4.4 PLC Raw Inputs and Outputs Reverse Status

If a raw digital input has a reverse status (0 for on/running/open, 1 for off/inactive/closed), in FB logic, after the AW_DI_MAP function block, a NOT function block is required for the output variable. Use of negation pins is not permitted. In general, all Boolean signals used in the PLC program shall represent the status as: True for ON/Running/Opened and False for Off/Stopped/Closed.

Wherever possible, the 1 or TRUE state for a tag should match the tag name meaning. For example, the value of tag PSRAMPR-PUMP-01-FAIL-HI shall be 1 or TRUE when the pump motor has a failure.

4.4.5 PLC I/O Module Monitoring

All PLC input/output modules and communication modules shall be programmed to provide module status for monitoring at the SCADA screens. The module health bit or register shall be sent to the SCADA HMI.

4.4.6 PLC Program Structure

The PLC program tasks shall be organized in a modular and logical manner. For example, I/O conditioning may be one logic section, and another might be Lead/Lag logic for pump rotation. Example project logic sections that meet this intent are shown in Figures 4 and 5.

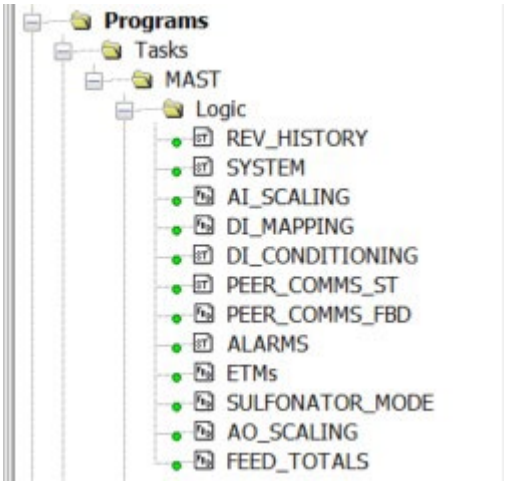


Figure 4 PLC Logic Sections Structure



Figure 5 Treatment Facility Logic Sections Typical

4.5 PLC Program Change Documentation

4.5.1 PLC Program Change Record

Each PLC shall have a Structured Text logic section "REV_HISTORY" *as the first section*. In the Rev History, each major program change shall be documented by Date, Name, and Notes as shown below:

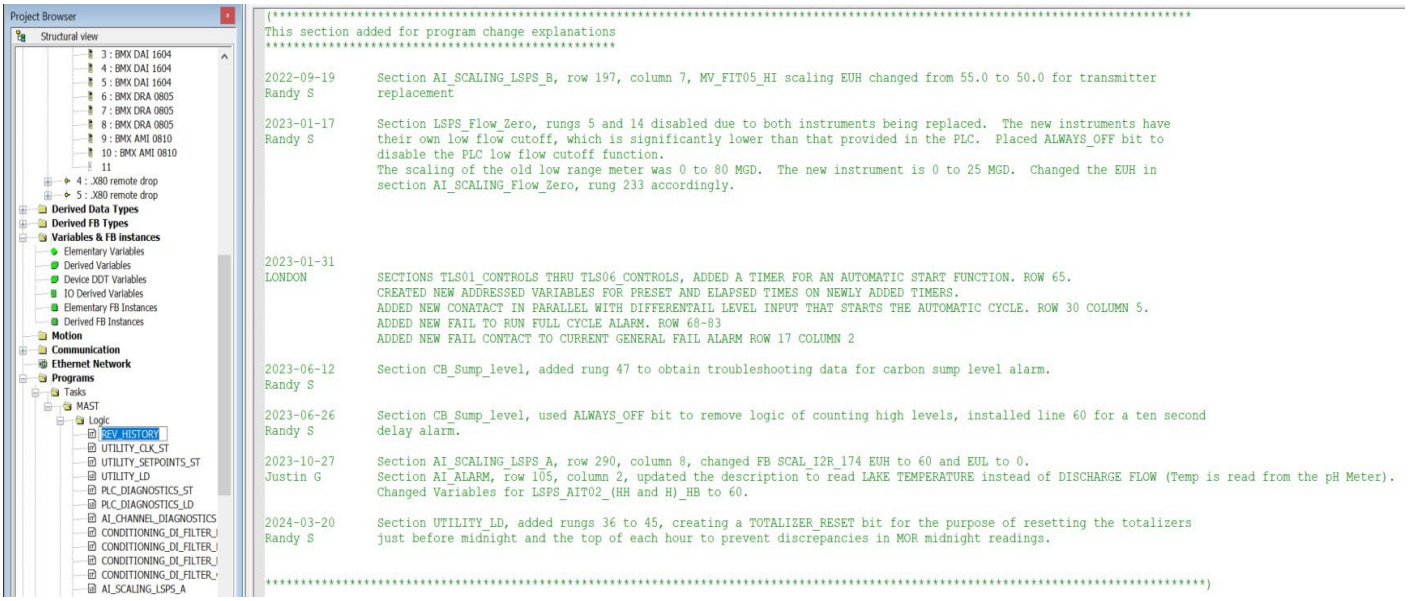


Figure 6 PLC Program Revision History Example

Section 5: OIU Configuration and Programming

5.1 General

The control system Programmer shall use the following standards to develop equipment displays, animations, screen layouts, alarms and events, historian and trending, and security configurations for all Austin Water OIUs. The Austin Water SCADA Division will provide an electronic copy of a typical process unit OIU configuration file.

5.1.1 Operation Interface Unit

Schneider Electric's Harmony OIU is the model specified by Austin Water for local touch screen operator controls. The details of the OIU model number are defined in Austin Water Facility Engineering Standards, Division 17, Section 17600.

5.1.2 OIU Development Software

Schneider Electric's Vijeo Designer Suite shall be used for OIU program development. The control system Programmer shall verify the Vijeo software version with the Austin Water SCADA Division before OIU program development.

5.2 OIU Programming and Configuration

5.2.1 OIU Project File Name

The OIU program file shall be named according to the following format. The OIU project file shall be saved in the VDZ file format.

Facility Code – Area Code – "OIU" – No.

Example: North Anderson Mill Pump Station OIU No. 6

The OIU file name is: PSR-AMPR-OIU-06

Table 6 shows the naming codes that apply for this equipment.

Table 6 OIU Tag Naming Convention Example

Code Type	Value	Reference
Facility Code	PSR	INFOR EAM Page 5
Area Code	AMPR	INFOR EAM Page 52
Position Code Abbreviation	nul	*in some cases CP
Position Number	1	Select from 1-99
Subcomponent Type	OIU	INFOR EAM Page 157
Number	01	Select from 01-99

5.2.2 OIU Project Database

All database tags used in the Vijeo Designer project file shall be imported from the PLC program. The OIU program shall use the exact same database tags as the PLC Program. The Programmer shall export the Schneider PLC database in the XVM file format and use the XVM file to import all database tags to the Vijeo Designer database.

Database design requirements:

1. The Vijeo designer project file shall have all PLC database tags.
2. The Vijeo designer project file shall import and link to the PLC XVM database file.
3. The Control Expert Data Dictionary function shall be turned on.

5.2.3 Harmony OIU Memory Card

Each OIU shall have a memory card (32GB minimum) installed. The OIU Project Editor File (checkbox) shall be enabled to download to the OIU memory card along with the runtime data files. (See 5.2.6 Project File Retrieval.)

5.2.4 Harmony OIU Time Synchronization with PLC Clock

All OIUs shall be configured to use the method described in Appendix C to configure the Harmony OIU to synchronize the OIU date/time with the local PLC's clock.

If the OIU is communicating with multiple PLCs, the Programmer shall contact the Austin Water SCADA Division to determine which PLC will be used to synchronize the OIU clock.

5.2.5 Multiple OIU Targets

A single Vijeo Designer project shall be used for each remote site or each Area of a treatment facility. The project must contain a unique target instance for each OIU.

5.2.6 Project File Retrieval

All OIUs shall be configured to allow for the project file to be retrieved from the OIU. This feature shall be enabled for all targets. To enable this feature, the following options must be configured per target:

Target Settings -> Download Settings -> Include Editor Project – Enabled
Target Settings -> Data Locations -> Data Files / Forms – Secondary Drive
See the image below to view the settings in the Vijeo editor:

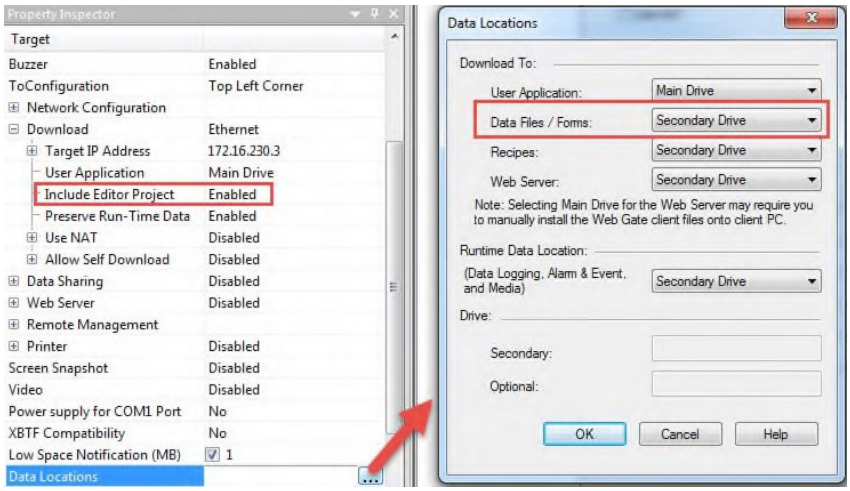


Figure 7 Project Retrieval Settings

5.2.7 Push Button Configuration

Operation push buttons for equipment operations such as START, STOP, RESET, or set point entry shall be configured with security to prevent an unauthorized person from operating equipment or changing the equipment set point. Refer to section 5.5.1 for security configuration.

5.3 OIU Screen Design

5.3.1 Equipment Color Scheme

Equipment shown on the OIU screens shall use the following equipment color animation scheme:

Table 7 Equipment Status Color Scheme

Status	Color
On/Running/Open	Red
Off/Stopped/Closed	Green
Alarm	Yellow

5.3.2 Analog Values Display

To determine display decimal format for each analog, coordinate with AW project team. These vary with instrument type, range, accuracy and operational preference.

5.3.3 Equipment Animation

Equipment animations used in a typical pump station are defined in the following screen. The Programmer shall submit the equipment animation for any equipment not listed in the following Legend Screen to the Austin Water SCADA Division for approval before OIU program design.

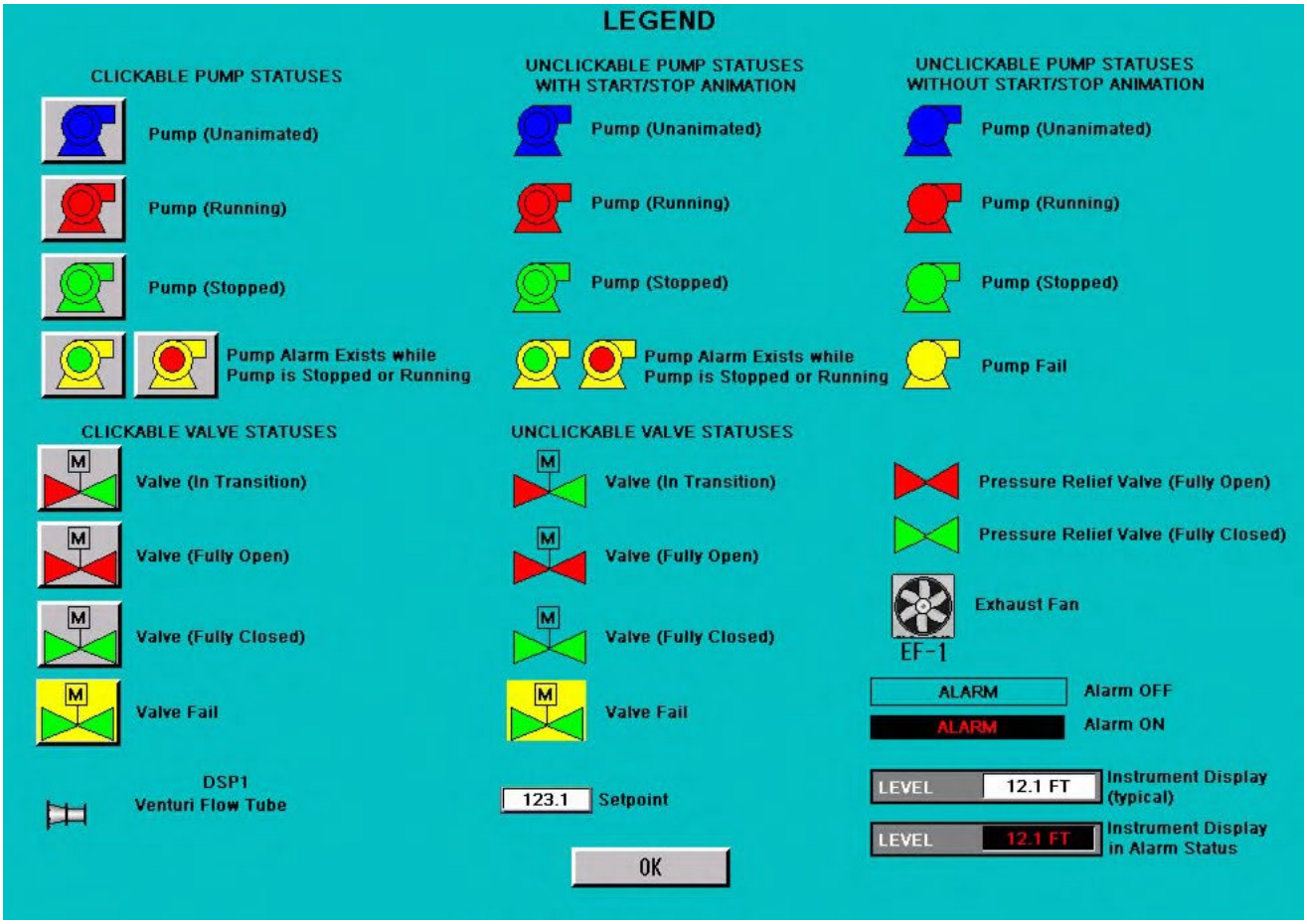


Figure 8 Legend Screen

5.3.4 Screen Layout for water distribution and collection systems (WDCS)

For the WDCS, the standard process screen consists of four screen sections: Screen Title, Main Screen Section, Alarm Section, and Navigation Bar Section. Process areas at other facilities may vary the standard screen layout.

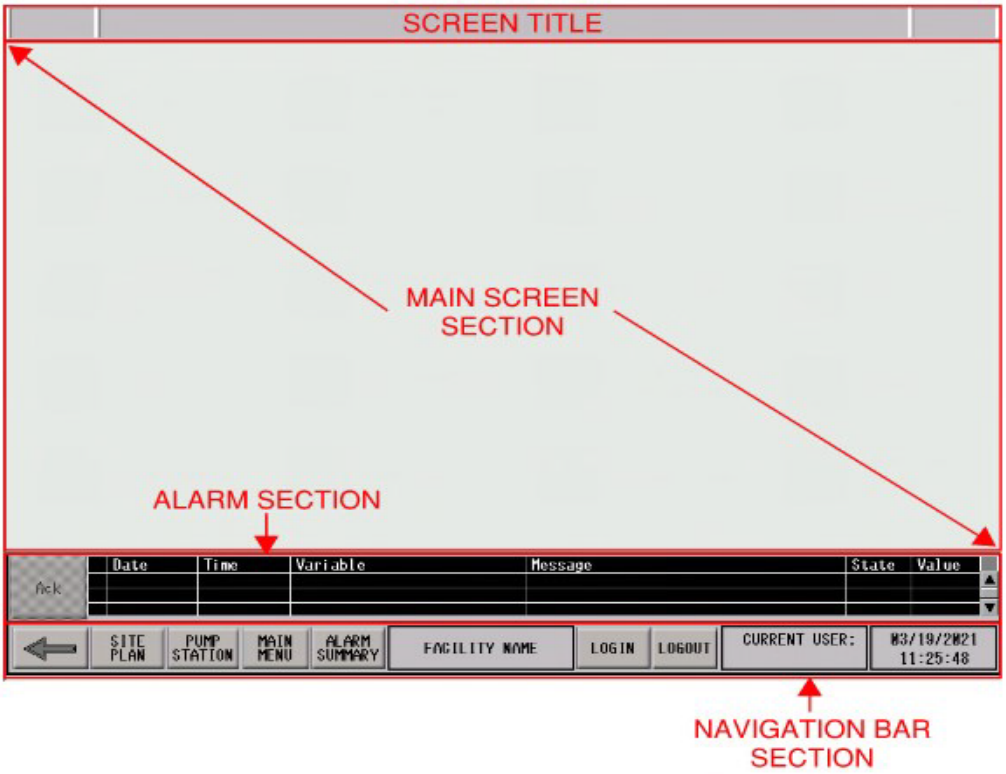


Figure 9 Standard Screen Layout

Each main process screen has a navigation bar that provides screen navigation functions. The description and functions of each button on the navigation bar are shown on the following screen. Operators can acknowledge a selected alarm by pressing the “Ack” button.

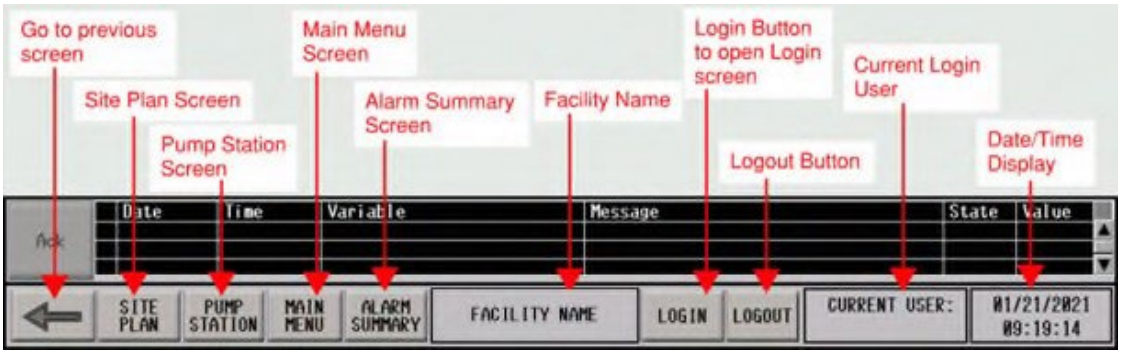


Figure 10 Navigation Bar Function Key

5.4 OIU Screen Design

The following sections provide a template screen set for a pump station facility. Note that for other types of stations, the number of screens and types of screens will vary.

5.4.1 Site Plan Screen

This screen shall show the overall facility layout, pump status, and instrument readings.

Example screen:

Table 8 OIU Tag Naming Convention Example

Code Type	Value	Reference
Facility Code	PSR	INFOR EAM Page 5
Area Code	AMPR	INFOR EAM Page 52
Position Code Abbreviation	nul	*in some cases CP
Position Number	1	Select from 1-99
Subcomponent Type	OIU	INFOR EAM Page 157
Number	01	Select from 01-99

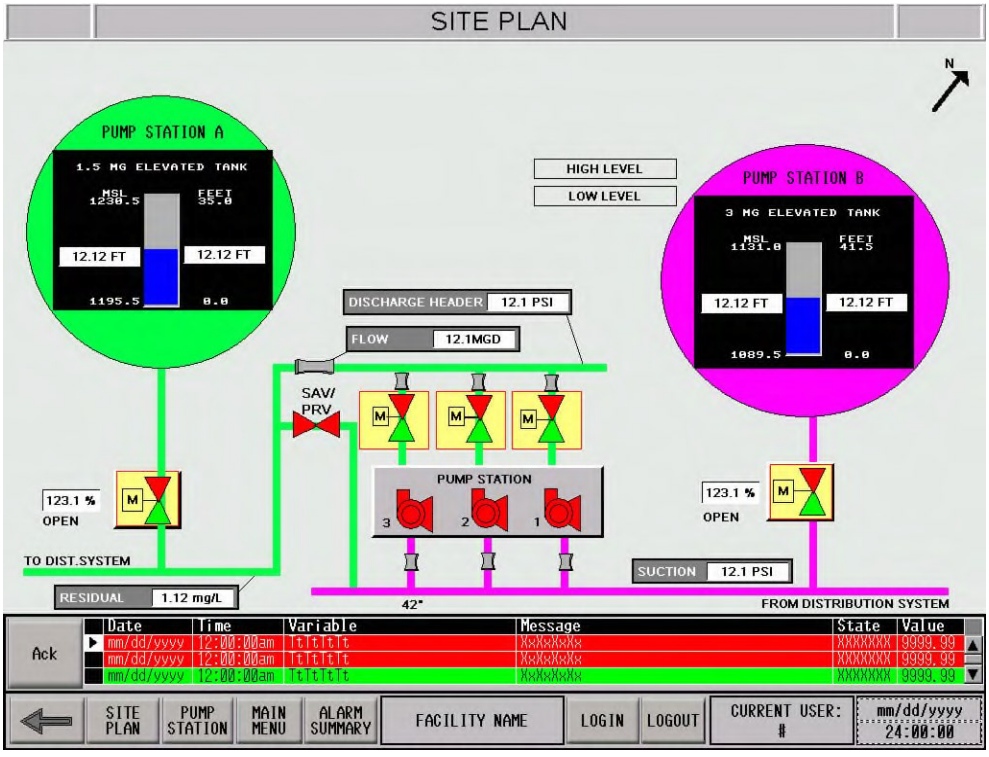


Figure 11 Site Plan Screen

Screen Design Requirements:

1. The Site Plan shall be the default screen when the OIU is powered up.
2. Each labeled button shall open a specific screen associated with that area or function, for example the “Pump Station” button shall open the Pump Station screen and buttons with valve symbols shall open the Fill Valve screen.

Security Configuration: None.

Screen Navigation: This screen can be opened by pressing the “Site Plan” button in the Navigation Bar or from the Main Menu screen.

5.4.2 Pump Station Screen

This screen shall show pump station layout, pump status, and instrument readings.

Example screen:

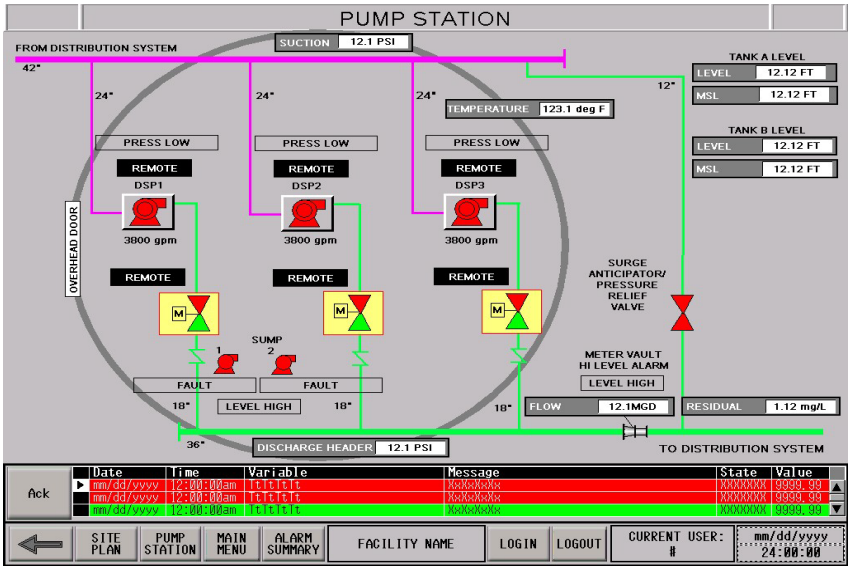


Figure 12 Pump Station Screen

Screen Design Requirements:

The buttons with pump symbols shall open the Pump Operation screen.

Security Configuration: None.

Screen Navigation:

1. This screen can be opened by pressing the “Pump Station” button on the Navigation Bar, the Main Menu screen, or the Site Plan screen.

5.4.3 Menu Screen

The Main Menu screen identifies all of the primary process screens and provides one button access to each.

Example screen:

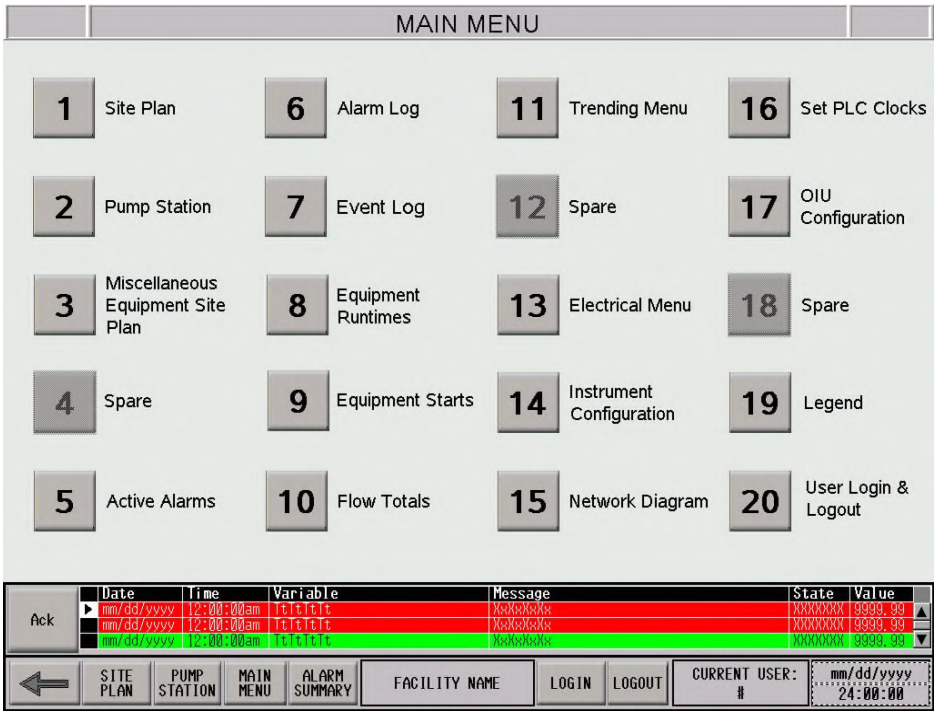


Figure 13 Main Menu Screen Design Requirements:

1. Each button shall open the screen listed to the right of the button.

Security Configuration:

Button “17”: ADMIN

Screen Navigation:

This screen can be opened by pressing the “Main Menu” button in the Navigation Bar.

5.4.4 Miscellaneous Equipment Site Plan Screen

This screen shall show miscellaneous equipment layouts and statuses. It provides a quick overview of other instruments and statuses that are not covered by the Site Plan screen, or instruments and statuses of another process at the site.

Example screen:

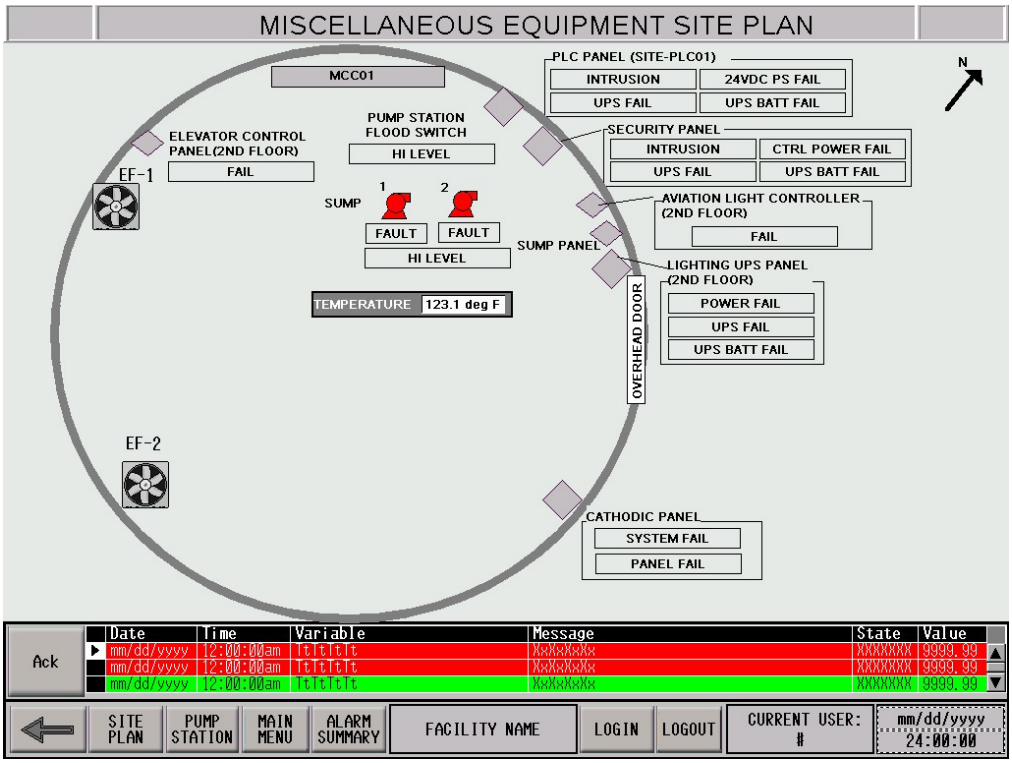


Figure 14 Miscellaneous Equipment Site Plan Screen

Screen Design Requirements:

Equipment not installed on the ground floor shall be labeled with text showing which floor the equipment is installed on.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the "Miscellaneous Equipment Site Plan" button.

5.4.5 Electrical Menu Screen

This screen shall show a menu of all electrical equipment screens.

Example screen:

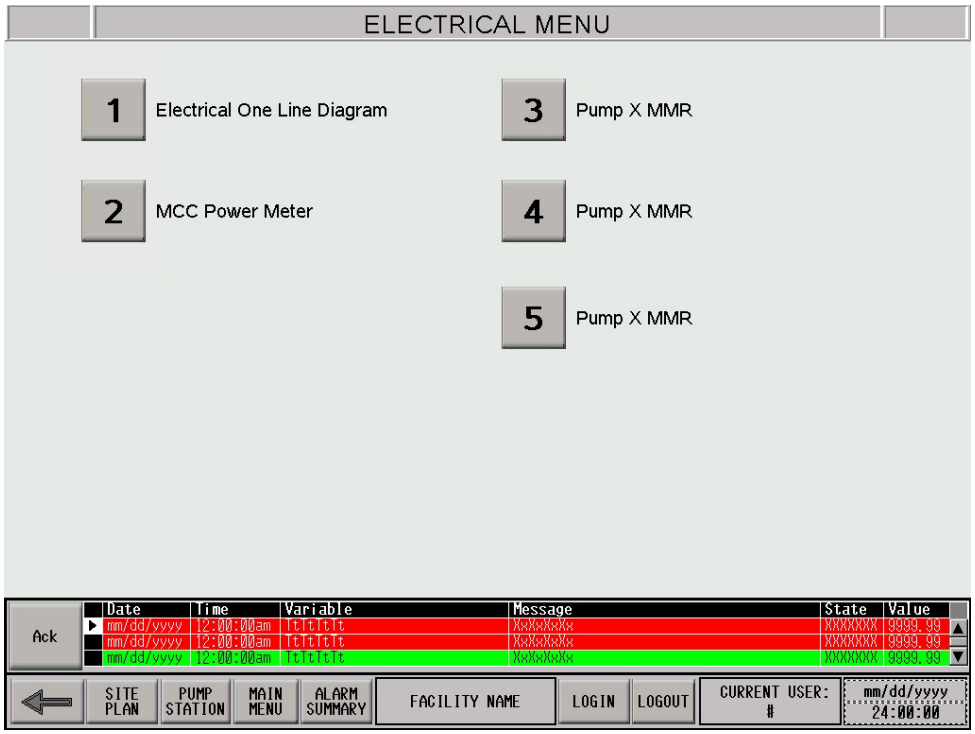


Figure 15 Electrical Menu Screen

Screen design requirements:

1. Each button shall open the screen associated with the title to the right of the button.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the “Electrical Menu” button.

5.4.6 Electrical One Line Diagram Screen

This screen shall show the electrical system diagram.

Example screen:

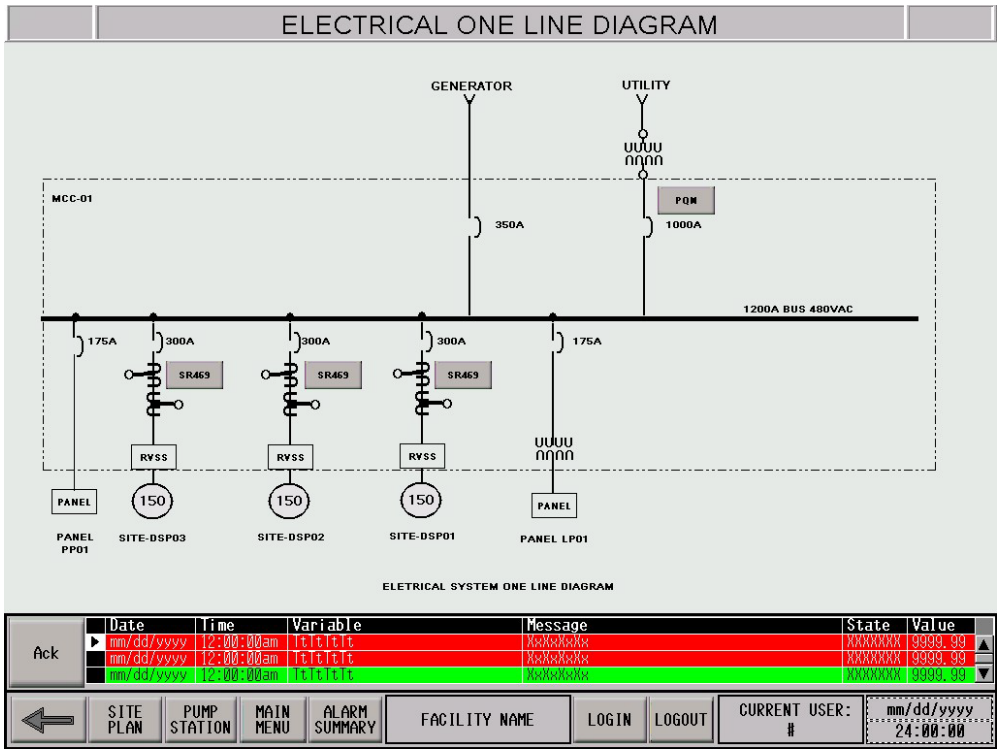


Figure 16 Electrical One Line Diagram Screen

Screen design requirements:

1. Buttons “SR469” shall open the Pump Motor Management Relay screen.
2. Button “PQM” shall open the MCC Power Meter screen.
3. This type of screen requires animation to depict breaker statuses, utility feed statuses, generator statuses, transfer switch statuses, etc. if the PLC is programmed to provide these status signals.

Note: SR469 is an old model of motor management relay. This screen shall use the exact motor management relay model number to label the buttons.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Electrical Menu and pressing the “Electrical One Line Diagram” button.

5.4.7 Network Diagram Screen

This screen shall show a typical pump station SCADA PLC network diagram.

Example Screen:

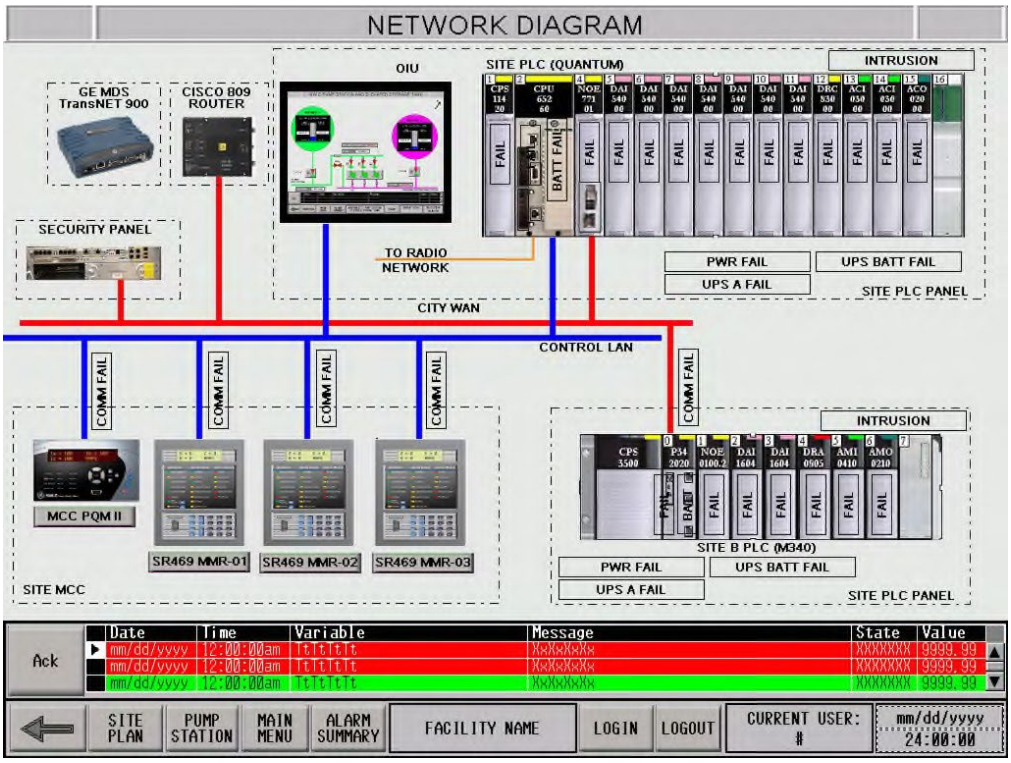


Figure 17 Network Diagram Screen

Screen design requirements:

1. Provide “COMM FAIL” alarm displays for each device connected to a network.
2. Provide “PWR FAIL”, “UPS X FAIL”, and “UPS BATT FAIL” alarm displays for each device that has and is monitoring a UPS.
3. Provide “INTRUSION” alarm displays for each device that monitors intrusion.
4. City WAN network shall be in RED and local PLC/Device network shall be in BLUE
5. Network equipment IP addresses shall not be shown on the screen.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the “Network Diagram Screen” button.

5.4.8 Pump Operation Screen

Each controllable pump shall have its own operation screen.

Example Screen:

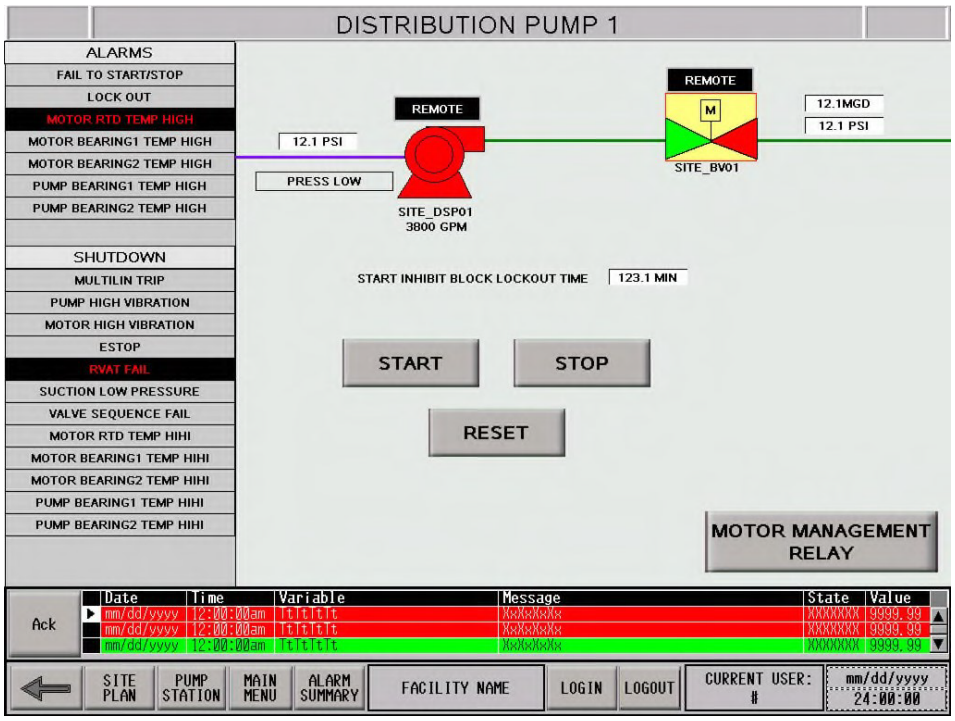


Figure 18 Pump Operation Screen

Screen design requirements:

1. The pump alarm list on the left side of the screen shall be animated. See the animated alarms “MOTOR RTD TEMP HIGH” and “RVAT FAIL” for examples of active alarms.
2. Discharge valve and suction/discharge instrument reading shall be shown on this screen.
3. The pump’s lockout timer reading shall be shown on this screen.
4. The “START” and “STOP” buttons shall be grayed out when the pump is not in remote mode. The buttons shall always be visible to indicate there is a start/stop capability.
5. The “RESET” button shall be grayed out when pump has no alarm. The button shall always be visible to indicate there is a reset capability.
6. The “MOTOR MANAGEMENT RELAY” button will open the Pump Motor Management Relay screen.
7. Some pump facilities shall include an “Out of Service” button that performs a normal shutdown of the pump when pump is running and disables the pump remote start.

Security Configuration:

1. Button “START/STOP”: OPERATOR, SUPERVISOR.

2. Button “RESET”: OPERATOR, TECHNICIAN, SUPERVISOR, ADMINISTRATOR.

Screen Navigation:

1. This screen can be opened by going to the Pump Station screen and pressing one of the Pump buttons.
2. This screen can be opened by pressing the “PUMP XXXX GPM” button on the Pump Motor Management Relay screen.

5.4.9 Fill Valve Screen

Each control valve shall have its own operation screen.

Example Screen:

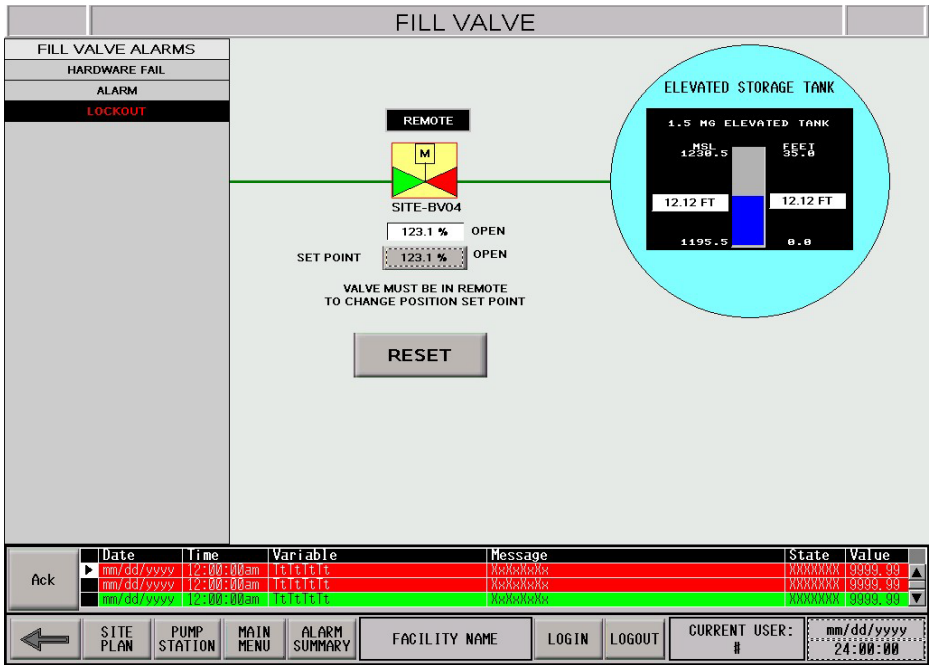


Figure 19 Fill Valve Screen

Screen design requirements:

1. Valve alarm list is shown on the left side of the screen. Each alarm shall be animated. See animated alarm “LOCKOUT” for an example of an active alarm.
2. The “RESET” button shall be grayed out when the valve has no alarm. The button shall always be visible to indicate there is a reset capability.
3. The “SET POINT” button shall be grayed out and disabled for unauthorized users. When authorized users click this button, it will display the OIU Numeric Keypad to allow users to enter a new setpoint.

Note: This screen can only be opened from the Site Plan screen.

Security Configuration:

1. Button “RESET”: OPERATOR, TECHNICIAN, SUPERVISOR, ADMINISTRATOR.
2. Set Point button: OPERATOR, SUPERVISOR.

Screen Navigation:

This screen can be opened by going to the Site Plan screen and pressing one of the Valve buttons.

5.4.10 Pump Motor Management Relay Screen

The purpose of this screen is to show all critical readings from a motor management relay.

Example Screen:

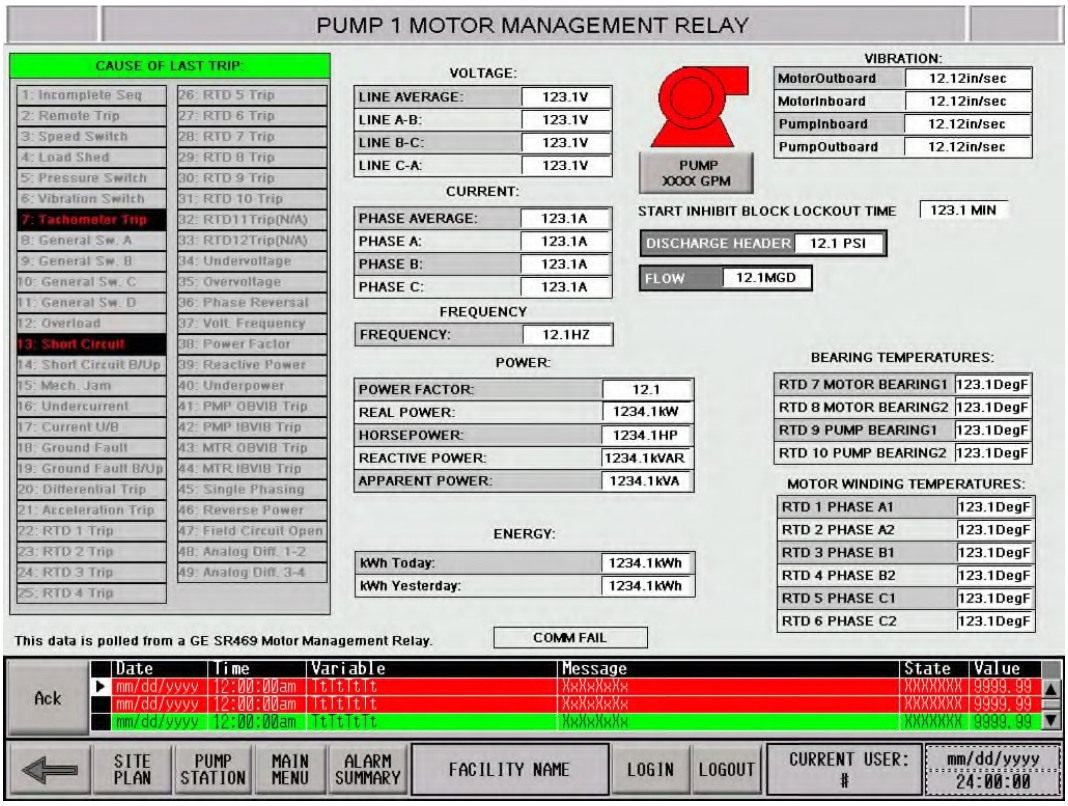


Figure 20 Pump Motor Management Relay Screen

Screen design requirements:

1. The motor management relay model number shall be shown in the bottom left corner of the screen.
2. Alarms in the CAUSE OF LAST TRIP section shall be animated. See animated alarms "Tachometer Trip" and "Short Circuit" in the screen for examples of active alarms.
3. The "PUMP XXXX GPM" button shall open the Pump Operation screen, shown above.

Security Configuration: None.

Screen Navigation:

1. This screen can be opened by going to a Pump Operation screen and pressing the "MOTOR MANAGEMENT RELAY" button.
2. This screen can be opened by going to the Electrical Menu and pressing one of the "Pump X MMR" buttons.

5.4.11 MCC Power Meter Screen

The purpose of this screen is to show all critical readings from an MCC Power Meter.

Example Screen:

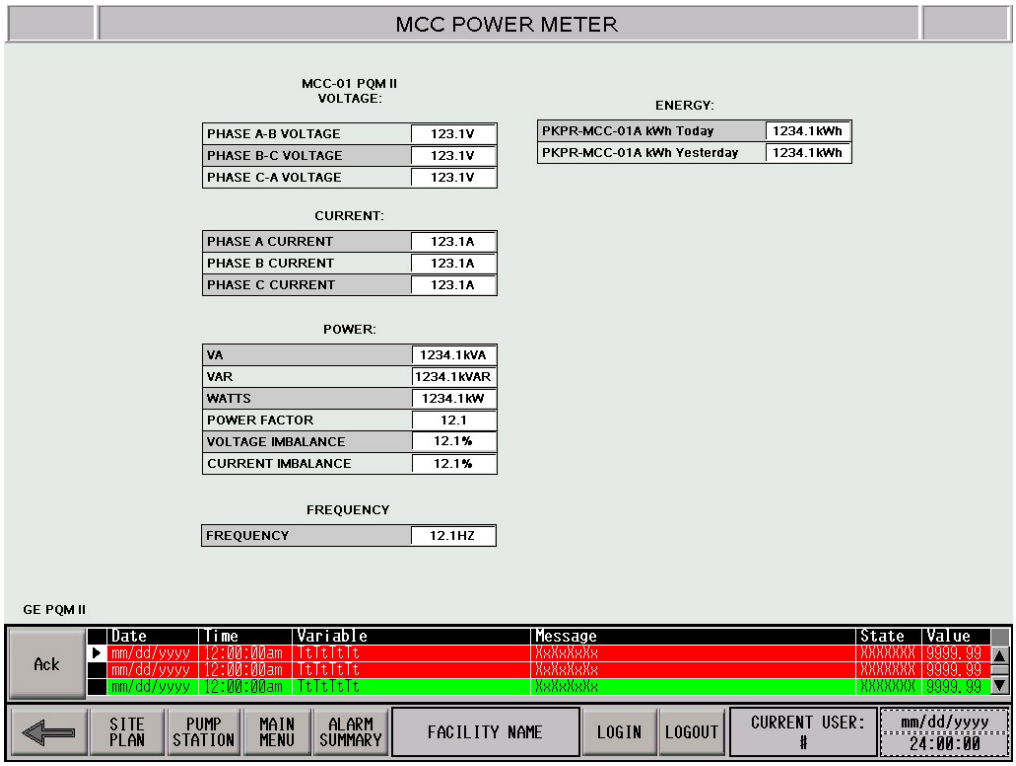


Figure 21 MCC Power Meter Screen

Screen design requirements:

The Power Meter's model number shall be shown in the bottom left corner.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Electrical Menu and pressing the "MCC Power Meter" button.

5.4.12 Equipment Runtimes Screen

This screen shall display the equipment runtimes.

Example Screen:

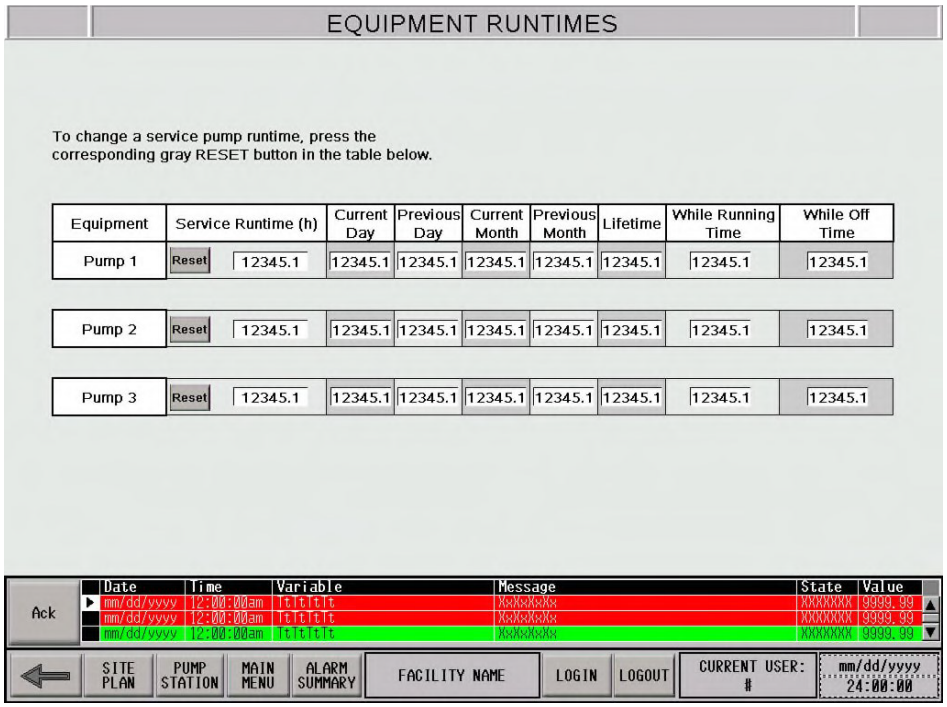


Figure 22 Equipment Runtimes Screen

Note: the value for runtime is stored as a real variable and will rollover once the value has reached 3.402x10^38.

Screen design requirements:

> The “Reset” button shall be grayed out and disabled for unauthorized users. The button shall always be visible to indicate there is a reset capability.

Security Configuration:

> Button “Reset”: TECHNICIAN, SUPERVISOR, ADMINISTRATOR.

Screen Navigation:

> This screen can be opened by going to the Main Menu screen and pressing the “Equipment Runtimes” button.

5.4.13 Equipment Starts Screen

This screen shall display the number of starts for equipment.

Example Screen:

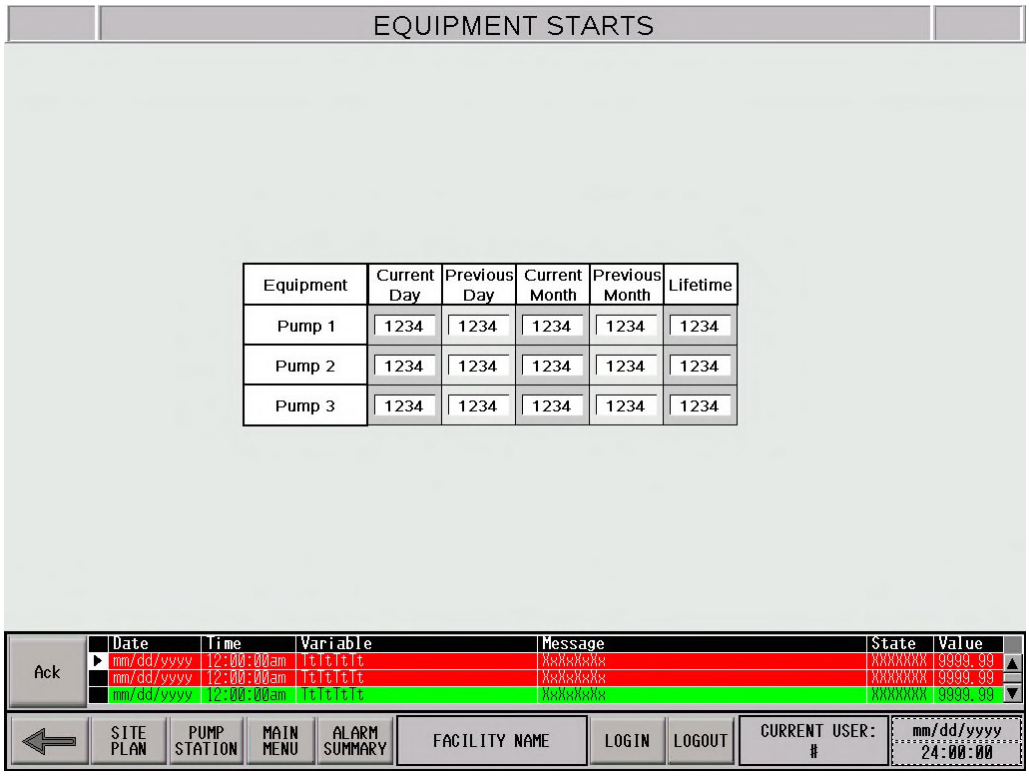


Figure 23 Equipment Starts Screen

Screen design requirements:

For each piece of equipment that has its starts counted, provide the number of starts on this screen.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the "Equipment Starts" button.

5.4.14 Flow Totals Screen

This screen shall display flow meter totalization.

Example Screen:

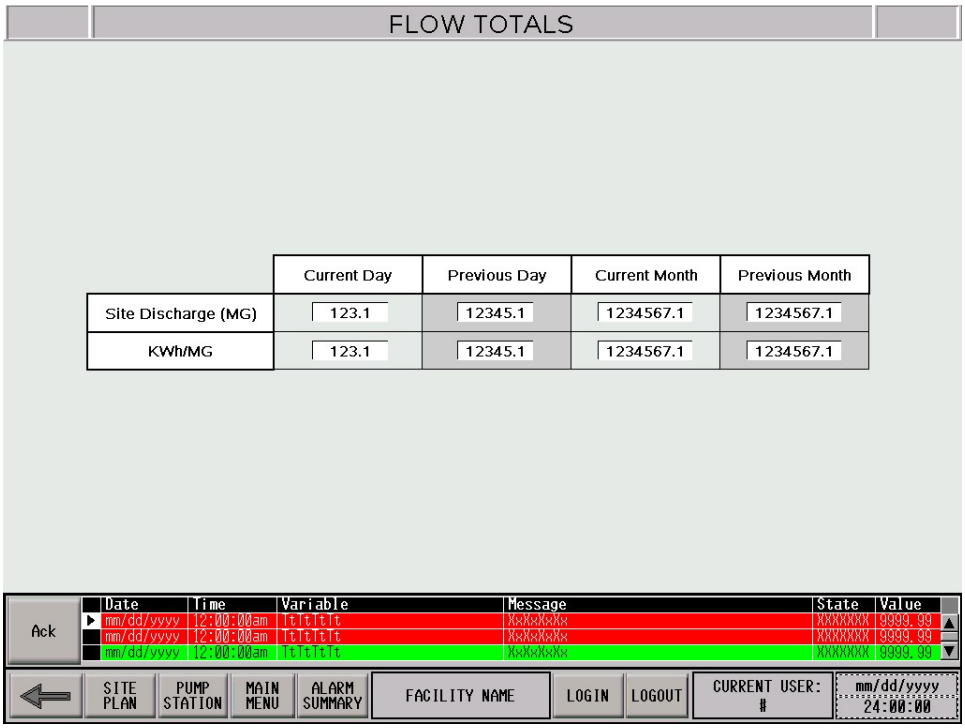


Figure 24 Flow Totals Screen

Screen design requirements:

All displays show corresponding real-time readings.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the “Flow Totals” button.

5.4.15 Instrument Configuration Screen

This screen provides each analog signal's configuration information. Signal tag name, description, engineering range, unit, alarm settings, and raw values are shown on this screen. The raw values displayed should be the actual raw values, with no adjustments made.

Example Screen:

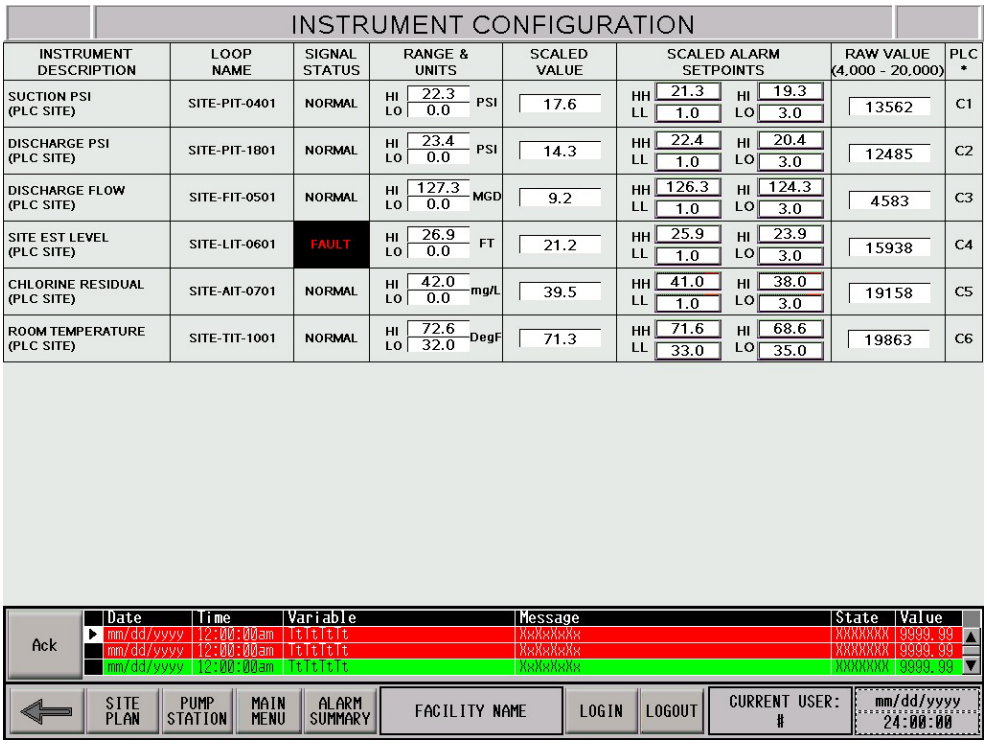


Figure 25 Instrument Configuration Screen

Note: the values displayed in the image above are examples, not actual readings.

Screen design requirements:

1. Provide analog displays for the scaled value, scaled alarm setpoints, and raw value of every point listed.
2. Provide signal status displays for every point. These will indicate whether the signal being received is good or faulty.

Security Configuration:

Alarm Setpoints boxes (HH, HI, LO, LL): TECHNICIAN, SUPERVISOR, ADMINISTRATOR.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the "Instrument Configuration" button.

5.4.16 Active Alarms Screen

This is an alarm summary screen that lists all active alarms. To acknowledge individual alarms, the Operator must use the "Cursor Up" and "Cursor Down" buttons to navigate to the specific alarm, and then press "Ack".

Example Screen:

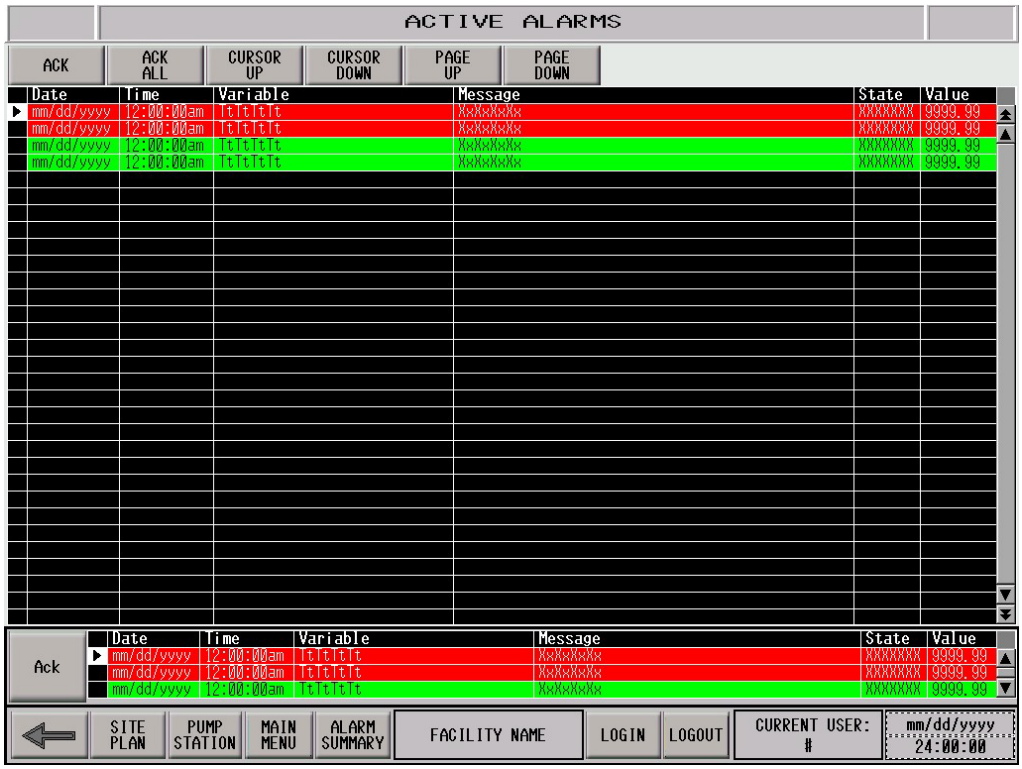


Figure 26 Active Alarms Screen

Screen design requirements:

1. Provide a display of exclusively the active alarms, including alarm date, time, variable, message, state, and value for each.
2. Button "CURSOR UP" shall move the cursor one up in the Alarm list.
3. Button "CURSOR DOWN" shall move the cursor one down in the Alarm list.
4. Button "PAGE UP" shall move the Alarm list one page up.
5. Button "PAGE DOWN" shall move the Alarm list one page down.
6. Button "ACK ALL" shall acknowledge all active alarms.

Security Configuration:

1. Buttons "ACK" and "ACK ALL" are only accessible to the following users: OPERATORS, TECHNICIANS, SUPERVISORS, and ADMINISTRATORS.
2. The remaining buttons are not configured with security.

Screen Navigation:

1. This screen can be opened by going to the Main Menu and pressing the “Active Alarms” button.
2. This screen can be opened by pressing the “Alarm Summary” button in the Navigation Bar.

5.4.17 Alarm Log Screen

The alarm log screen provides log information on each alarm.

Example Screen:

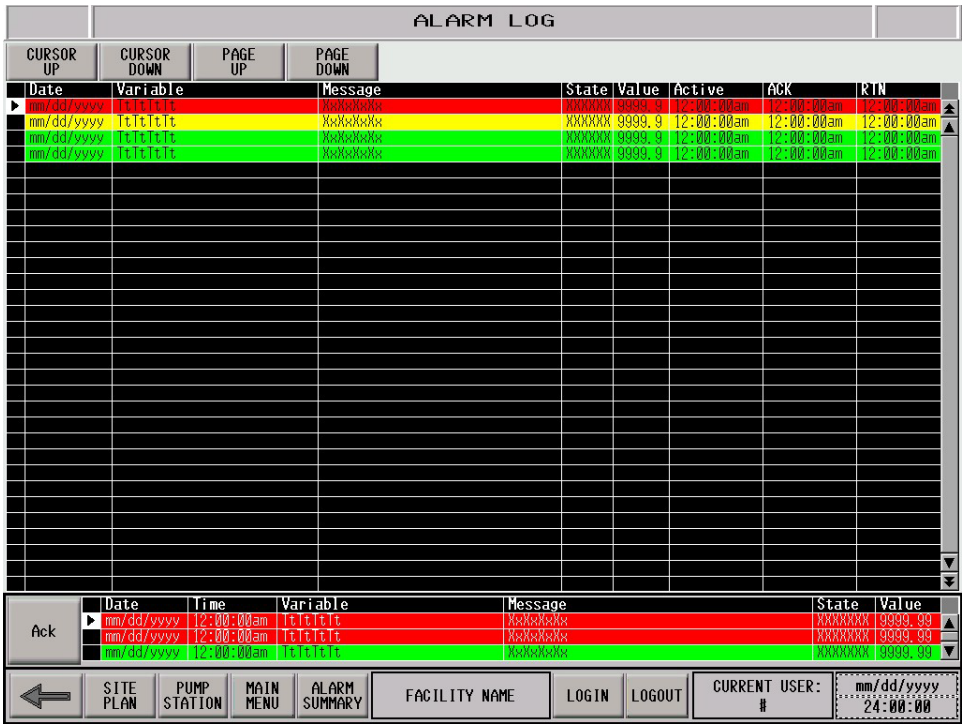


Figure 27 Alarm Log Screen

Screen design requirements:

1. Button “CURSOR UP” shall move the cursor one up in the Alarm Log list.
2. Button “CURSOR DOWN” shall move the cursor one down in the Alarm Log list.
3. Button “PAGE UP” shall move Alarm Log list one page up.
4. Button “PAGE DOWN” shall move Alarm Log list one page down.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the “Alarm Log” button.

5.4.18 Event Log Screen

This screen provides critical signal event log information.

Example Screen:

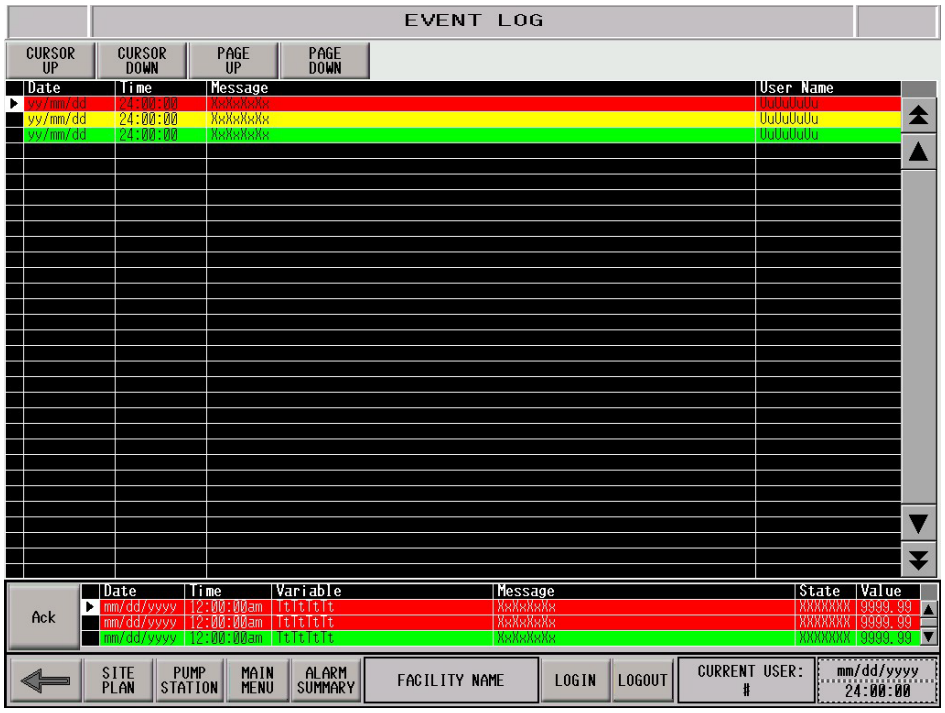


Figure 28 Event Log Screen

Screen design requirements:

1. Button “CURSOR UP” shall move the cursor one up in the Event Log list.
2. Button “CURSOR DOWN” shall move the cursor one down in the Event Log list.
3. Button “PAGE UP” shall move the Event Log list one page up.
4. Button “PAGE DOWN” shall move the Event Log list one page down.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the “Event Log” button.

5.4.19 Trending Menu Screen

This screen provides a menu of all trending screens for Instruments, Pump Vibration, Power Meters (PQM), and Pump Motor Management Relays (MMR). When a trend button is selected, the Operator shall be directed to the corresponding trend screen.

Example Screen:

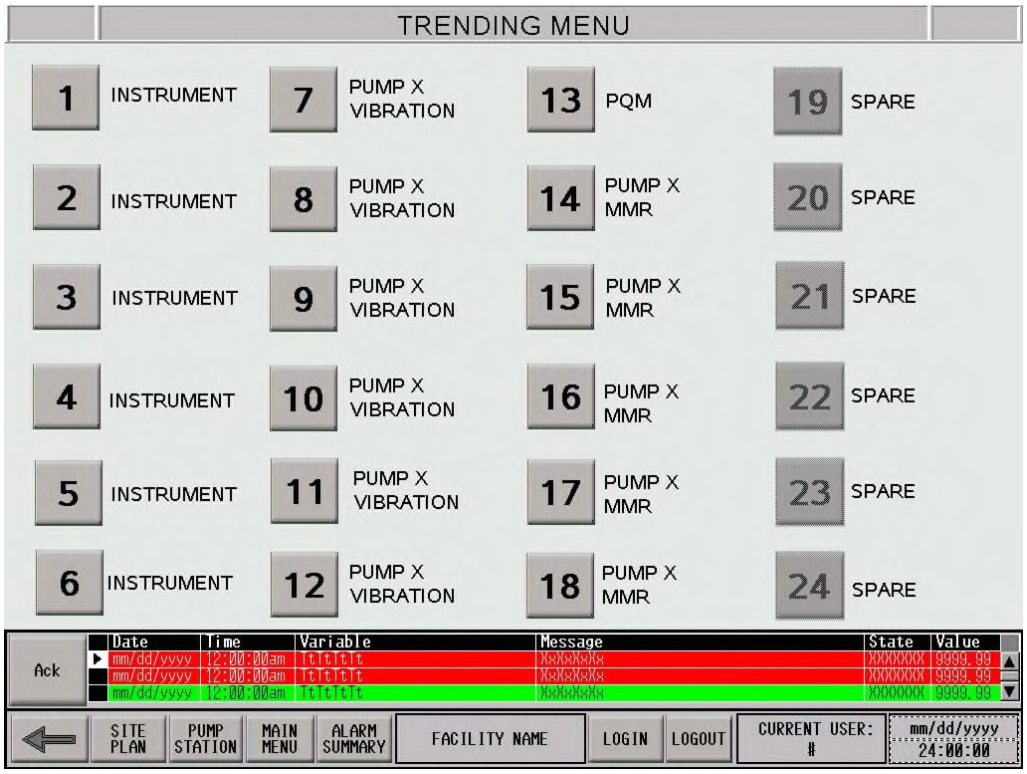


Figure 29 Trending Menu Screen

Screen design requirements:

This Trending Menu screen shall display clickable buttons for all trend screens.

Spare buttons shall be grayed out and disabled.

Security Configuration: None.

Screen Navigation:

This screen can be opened by going to the Main Menu screen and pressing the “Trending Menu” button.

5.4.20 OIU Screen — Trending Screens

The trending screens provide historical and real time data for properly configured points. Typically, only site critical signals are recorded in this manner.

Example Screen:

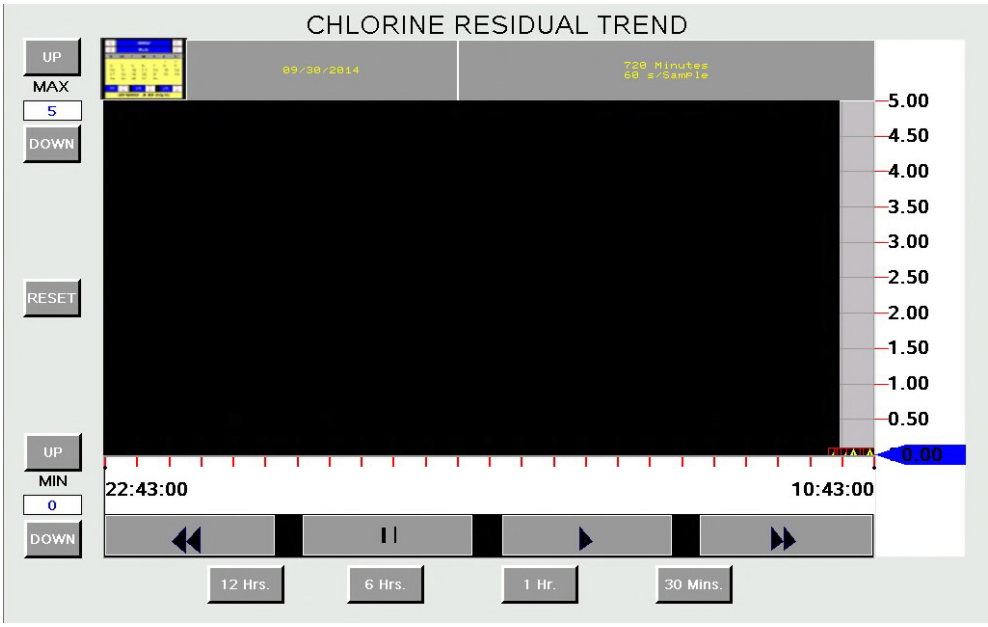


Figure 30 OIU Screen - Trending Screen

Screen design requirements:

1. Provide buttons to increase, decrease, and reset the minimum and maximum values for the output.
2. Provide buttons to change the trend graph's display duration to 12 hours, 6 hours, 1 hour, and 30 minutes.
3. Provide a trend graph that automatically updates each minute.
4. The trend graph shall have a minimum of 11 points displayed on the value axis.
5. The trending range for each trending screen shall be discussed with and approved by the Austin Water SCADA Division.

Security Configuration: None.

Screen Navigation:

These screens can be opened by going to the Trending Menu and selecting a trend to view.

5.4.21 OIU Configuration Screen

The OIU configuration screen is a set of default screens provided by Vijeo for basic OIU diagnostics and options. It consists of the following screens:

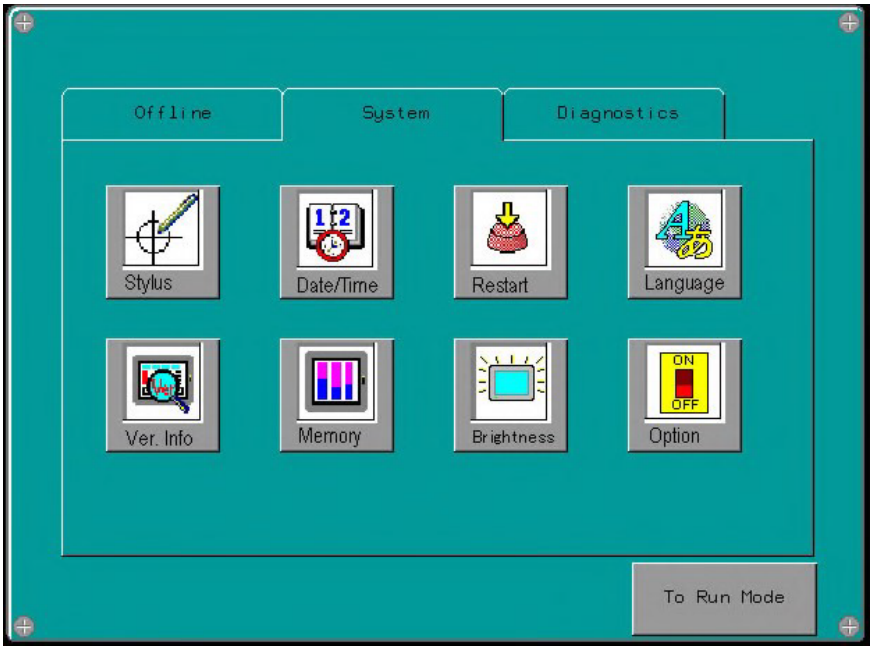


Figure 31 OIU Configuration Screen – System

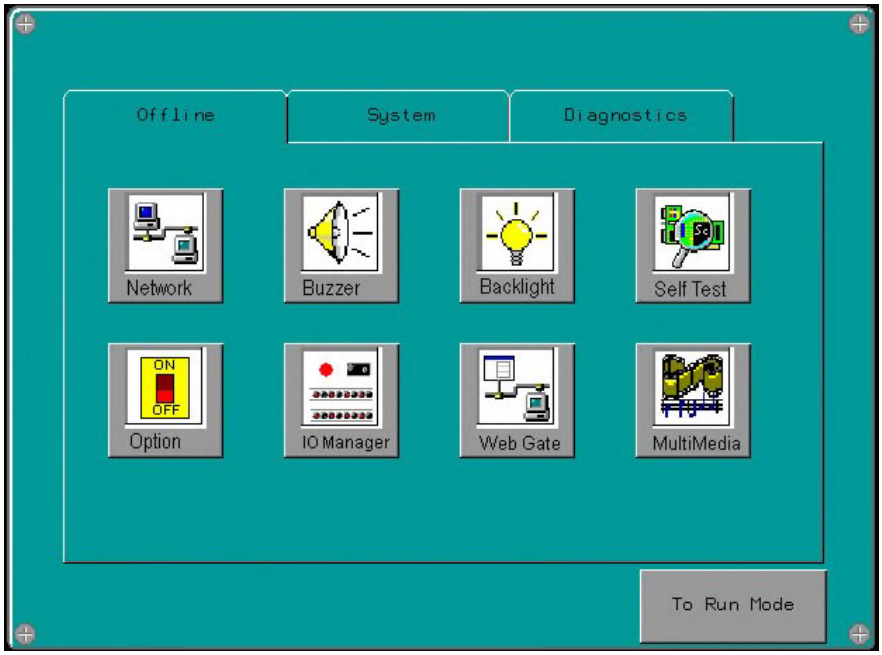


Figure 32 OIU Configuration Screen – Offline

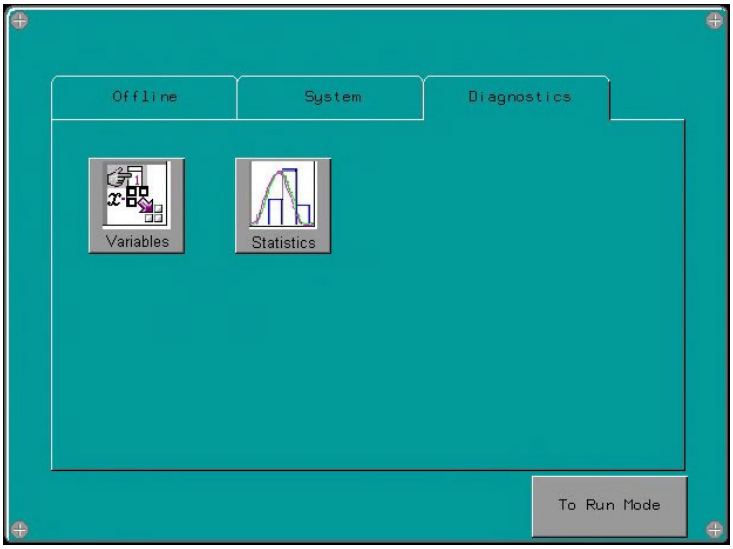


Figure 33 OIU Configuration Screen – Diagnostics

Screen design requirements:

None, they come with Vijeo projects.

Security Configuration:

Only ADMIN users are allowed to access and navigate through these screens.

Screen Navigation:

These screens can be opened by going to the Main Menu screen and selecting the "OIU Configuration" button.

5.4.22 OIU Numeric Keypad

The OIU has a numeric keypad that comes with Vijeo. It is used when entering numeric values such as setpoints. The screen is shown below.



Figure 34 OIU Numeric Keypad

Screen design requirements:

None, this comes with Vijeo projects.

Security Configuration: None.

Screen Navigation:

This keypad appears on numeric input controls when they are selected.

5.4.23 Confirm Action Popup Screen

When a critical action is being performed (such as a pump being started, stopped, or reset), a confirm popup will be displayed before the action is performed. The popup screen is shown below.

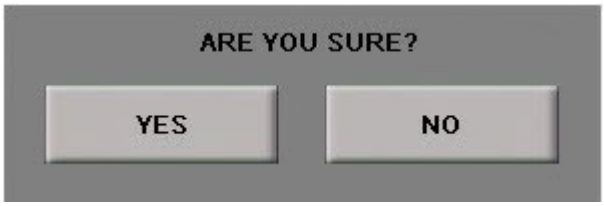


Figure 35 Confirmation Popup

Screen design requirements:

Pressing the “YES” button will allow the action to be performed.
Pressing the “NO” button will not allow the action to be performed.

Security Configuration: None.

Screen Navigation:

This popup appears whenever a critical action is being attempted.

5.5 OIU—Security

5.5.1 Configuration

The OIU system shall be programmed with a security configuration that shall prevent unauthorized personnel from operating the site's equipment and accessing control system settings and configuration. Each operation button or setting change button shall be configured with security, and an OIU user must log in with the right username and password to perform the operation tasks. If no screen activity is detected for a certain amount of time, the OIU system will automatically logout. To resume operation or change settings, the user must login again.

The standard user security levels are guest, operator, technician, supervisor, electrician, and administrator. The default user is guest. The guest user can navigate screens but cannot operate any equipment or change any settings. The Austin Water SCADA Division will provide initial default passwords for all users other than guest.

The security settings are implemented by the administrator during configuration. The security levels shall be configured using the bitmask method provided in Vijeo Designer. This method provides a greater level of control over which operations the different users can access.

The matrix of the Vijeo Designer bitmask per user is shown in the following table.

Table 9 OIU Security Matrix for Standard Users

Project User	Security Level, decimal	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
oper	1	0	0	0	0	0	0	0	1
tech	2	0	0	0	0	0	0	1	0
super	4	0	0	0	0	0	1	0	0
elec	8	0	0	0	0	1	0	0	0
admin	128	1	0	0	0	0	0	0	0

Similarly, the matrix of the Vijeo Designer bitmask per *security level* is shown in the next table.

Table 10 OIU Security Matrix – Naming Convention for Additional Security Groups

Project Security Group	Security Level, decimal	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
SU_OP	5	0	0	0	0	0	1	0	1
SU_TE_OP	7	0	0	0	0	0	1	1	1
EL_SU	12	0	0	0	0	1	1	0	0
EL_SU_OP	13	0	0	0	0	1	1	0	1
EL_SU_TE	14	0	0	0	0	1	1	1	0
AD_TE	130	1	0	0	0	0	0	1	0
AD_SU	132	1	0	0	0	0	1	0	0
AD_SU_OP	133	1	0	0	0	0	1	0	1
AD_SU_TE	134	1	0	0	0	0	1	1	0
AD_SU_TE_OP	135	1	0	0	0	0	1	1	1
AD_EL_TE	138	1	0	0	0	1	0	1	0
AD_EL_SU	140	1	0	0	0	1	1	0	0
AD_EL_SU_OP	141	1	0	0	0	1	1	0	1
AD_EL_SU_TE	142	1	0	0	0	1	1	1	0
ALL_LOGINS	143	1	0	0	0	1	1	1	1

The actions permitted per user may vary per type of facility and current operations management preferences and standards. Collaboration is required to determine which control actions are permitted per user. For instance, only electricians are allowed to operate transfer switches; only administrator is allowed to make configuration changes.

5.5.2 OIU Screen—Login and Logout Operation

To login to the OIU system, the OIU user can click the "Login" button on the navigation bar. A login screen shall be shown in the top left corner. The user can type their username and password on the virtual keypad. After entering the username and password, the user **MUST** press the unlock button (the button with a lock icon) to login to the system. The username of the currently logged in user shall be shown on the navigation bar.

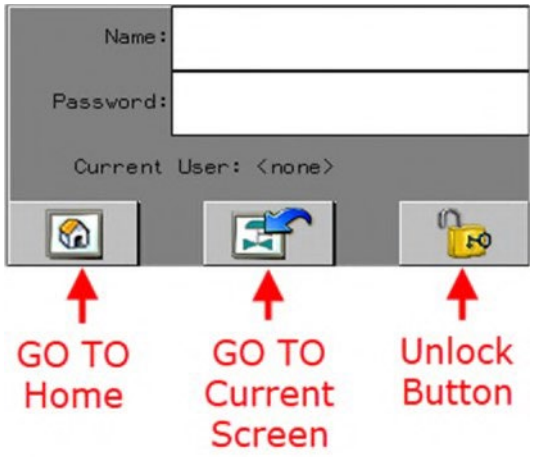


Figure 36 OIU Login Screen

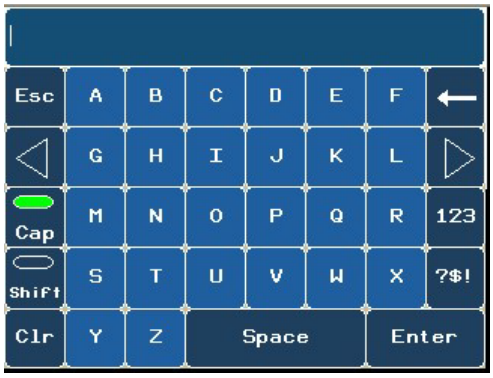


Figure 37 OIU Login Virtual Keypad

To log out, the operator can press the "Logout" button on the navigation bar.

5.5.3 Insufficient Permission Screen

When a user attempts to perform an action that they do not have the authority to do, they will be taken to a screen explaining that they do not have the authority to perform that action. See the example screen below:

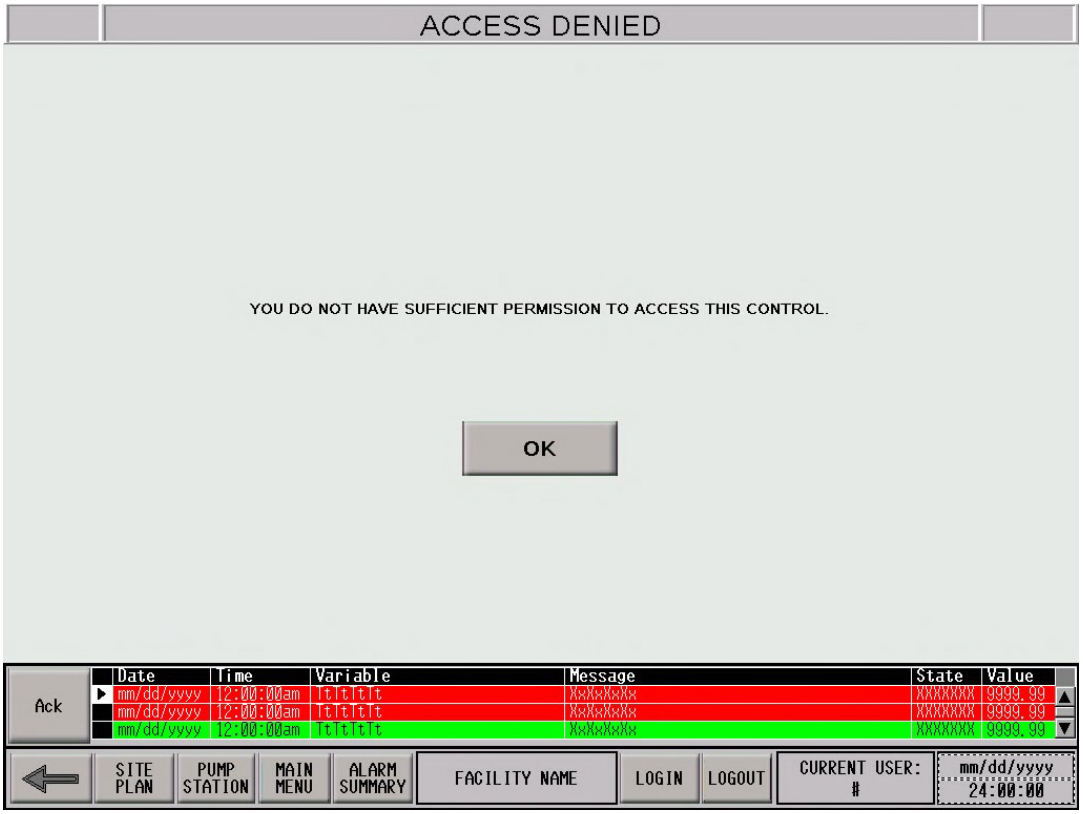


Figure 38 Access Restricted Screen

Screen design requirements:

The “OK” button will take the user back to the previous screen.

Security Configuration:

None.

Screen Navigation:

This screen appears whenever a user attempts to perform an action that they do not have the authority to do.

Section 6: Operator Workstation and Server Configuration (placeholder)

We are revising the SCADA top end graphics standards and will provide content at a later date.

Appendix A: Tag Name Descriptor and Qualifier Tables

Table 11 Tag Name Function Descriptor Codes

Code	Field Device INPUTS, Function Description
ALOX	Equipment PLC Lockout Relay Status
ALRM	Common Alarm
ALRT	Common Failure Alarm
AUTO	Motor Auto Switch
BATT	Low Battery Alarm
BFTC	Breaker Fail to Close Alarm
BFTO	Breaker Fail to Open Alarm
BLDN	Blowdown Cycle On
BYPS	Bypass Condition Status
CLSD	Closed
CMFL	Comm Fail
COC	Breaker in Connected Position
CPRM	Equipment Close Permissive
DCS	DCS Switch Position
EMRG	Automatic Transfer Switch Emergency Power Status
ENAB	Enabled Status
ESTP	Emergency Stop Condition
FAIL	Fail Alarm
FAULT	Motor Fault
FLOW	Local Auto Flow Switch
FSRT	Equipment Fail to Start
FSTP	Equipment Fail to Stop
FTC	Equipment Fail to Close Alarm
FTO	Equipment Fail to Open Alarm
FUSB	Blown Fuse Alarm
GFI	Ground Fault Alarm
ILCK	Breaker Interlock Permissive True
ILCK2	Main-Tie Interlock
INTR	Intrusion

Code	Field Device INPUTS, Function Description
INVL	Invalid Alarm
ISRV	Equipment In Service Mode
KEY	Loadbreak Switch Key In Status
LEAK	Leak Alarm
LOCK	Equipment Lockout Status
LOCL	Equipment Selector Switch LOCAL Position
MANT	Equipment Selector Switch MAINTENANCE Position
MCFA	PLC Memory Card Error
MCR	Master Control Relay
MLR	Motor Lockout Relay Alarm
MPR	Motor Protection Relay Alarm
NCSH	High Closing Torque
NORM	Normal Position
NOSH	High Opening Torque
NRML	Automatic Transfer Switch Normal Power Status
NSA	Equipment Normal Shutdown Alarm
OFF	Off Status
OFFA	Off Alarm
OPEN	Open
OPRM	Equipment Open Permissive
OVLD	Motor Overload
PFC1	Equipment Power Factor Correction Capacitor Bank 1 Blown Fuse
PFC2	Equipment Power Factor Correction Capacitor Bank 2 Blown Fuse
PFC3	Equipment Power Factor Correction Capacitor Bank 3 Blown Fuse
PFLD	Power Factor Lead Status
PFLG	Power Factor Lag Status
PNG1	PLC Timer Register Heartbeat
PWRA	Power Fail Alarm
RAKE	Auto Rake Permissive
RALM	Resettable Alarm is Present
RDY	Equipment Ready Status
RMOT	Motor Remote Switch

Code	Field Device INPUTS, Function Description
RTDA	Equipment RTD Temperature High Alarm
RUN1	Equipment Run Status 1
RUN2	Equipment Run Status 2
RUNC	Valve Closing Status
RUNN	Motor Running Status
RUNO	Valve Opening Status
SALM	Equipment Alarm Exists
SCUM	Motor Operating in Scum Auto Mode
SDSBL	Equipment Start is Disabled
SHDN	Shutdown Alarm
SOFF	Equipment Selector Switch OFF Position
SPRM	Equipment Start Permissive
SRTE	Bypass Starts Exceeded Counter Status
STBY	Stand-by Status
STP	Sludge Transfer Pump Select
STX	Equipment Stop Relay Status
SURG	Surge Alarm
TOC	Breaker Truck Position Status
TRBL	Trouble (Malfunction) Alarm
TRIP	Breaker Trip Status
VFDA	Variable Frequency Drive Alarm
VFTC	Control Valve Fail to Close
VFTO	Control Valve Fail to Open
XA	Surge Suppressor Alarm
XS	General Switch Input
ZSC	Limit Switch Closed
ZSO	Limit Switch Open
ZSxx	xx Position Switch where xx = Percent Position

Code	Field Device OUTPUTS, Function Description
CLOS	Loadbreak Switch Close Request from Host
OSRV	Equipment Out of Service Mode Command
RSET	Remote Reset Command
RST1	Equipment Service Runtime Reset Command
RST2	Equipment Lifetime Runtime Reset Command
STOP	Stop Command
STRT	Motor Start Coil
XFER	Transfer Coil
XRUN	Motor Run/Stop (or Start/Stop) Coil
XTOP	Motor Stop Coil
ZVC	Valve Closed Command
ZVO	Valve Open Command

Table 12 Tag Name Qualifier Codes

Qualifier Code	Description
I	Field inputs to PLC
O	Field outputs from PLC.
HI	Host inputs read from PLC
HO	Host outputs written to PLC
HB	Host bidirectional communication with PLC

The following table provides PLC and OIU tag names with the appropriate descriptor codes and qualifier codes, for reference.

Table 13 Example Tag Name Descriptor and Qualifier Codes

PLC & OIU Address	Description	Data Type	PLC Tag	OIU Tag
%M47	Pump 1 Disch Valve Common Fault Alarm	EBOOL	NAPR_BV01_ALRM_HI	PLC01.NAPR_BV01_ALRM_HI
%M37	Pump 1 Disch Valve Selector Switch Local Position	EBOOL	NAPR_BV01_LOCL_HI	PLC01.NAPR_BV01_LOCL_HI
%M46	Pump 1 Disch Valve High Torque Alarm	EBOOL	NAPR_BV01_NAH_HI	PLC01.NAPR_BV01_NAH_HI
%M503	Pump 1 Disch Valve Resettable Alarm Summary Bit	EBOOL	NAPR_BV01_RALM_HI	PLC01.NAPR_BV01_RALM_HI
%M36	Pump 1 Disch Valve Selector Switch Remote Position	EBOOL	NAPR_BV01_RMOT_HI	PLC01.NAPR_BV01_RMOT_HI
%M502	Pump 1 Disch Valve Alarm Active Summary Bit	EBOOL	NAPR_BV01_SALM_HI	PLC01.NAPR_BV01_SALM_HI
%M509	Pump 1 Disch Valve Discharge Valve Fail to Close	EBOOL	NAPR_BV01_VFTC_HI	PLC01.NAPR_BV01_VFTC_HI
%M510	Pump 1 Disch Valve Discharge Valve Fail to Open	EBOOL	NAPR_BV01_VFTO_HI	PLC01.NAPR_BV01_VFTO_HI
%M32	Pump 1 Disch Valve 0% Open	EBOOL	NAPR_BV01_ZSC_HI	PLC01.NAPR_BV01_ZSC_HI
%M35	Pump 1 Disch Valve 100% Open	EBOOL	NAPR_BV01_ZSO_HI	PLC01.NAPR_BV01_ZSO_HI
%MW1701	PLC01 Clock Year from Host	UINT	NAPR_PLC01_YEAR_HB	PLC01.NAPR_PLC01_YEAR_HB
%MW1710	PLC01 System Time Year	UINT	NAPR_PLC01_YEAR_HI	PLC01.NAPR_PLC01_YEAR_HI
%M521	Pump 1 Discharge Pressure High Shutdown	EBOOL	NAPR_PSH_001_HI	PLC01.NAPR_PSH_001_HI
%M2046	PLC01 Comm Fail Pump 1 Vib Controller	EBOOL	NAPR_VICT_001_CMFL_HI	PLC01.NAPR_VICT_001_CMFL_HI
%M702	Pump 1 Discharge Valve Position Open Loop Alarm	EBOOL	NAPR_ZA_BV1_HI	PLC01.NAPR_ZA_BV1_HI
%MW414	Pump 1 Discharge Valve Position Engineering Unit High	REAL	NAPR_ZIT_BV1_EUH_HI	PLC01.NAPR_ZIT_BV1_EUH_HI
%MW406	Pump 1 Discharge Valve Position Engineering Unit Low	REAL	NAPR_ZIT_BV1_EUL_HI	PLC01.NAPR_ZIT_BV1_EUL_HI
%MW10	Pump 1 Discharge Valve Position Scaled Value	REAL	NAPR_ZIT_BV1_HI	PLC01.NAPR_ZIT_BV1_HI
%MW323	Pump 1 Discharge Valve Position Raw Integer Value	INT	NAPR_ZIT_BV1_IM	PLC01.NAPR_ZIT_BV1_IM

Appendix B: Defined Function Blocks

The following document and DFBs contained within were designed by Team One Integration, LLC for the Austin Water WDCS in April 2021. Use of this library is being extended to all Austin Water facilities in August 2024. This document contains design procedures and concepts that are proprietary to the City of Austin Utilities, Austin Water. These procedures and concepts are confidential and may not be disclosed to any third party or used for any purpose other than for which this document is intended without the express written consent of the City of Austin Utilities, Austin Water. This information is protected by copyright and unauthorized reproduction or publication is prohibited.

Introduction

Austin Water has developed a series of custom function blocks (DFB) to be used by the system integrators during the development of PLC applications. These modules were created using version 13.0 of the Schneider Electric Unity-Pro PLC Development Software. These are compatible with Control Expert software. Here are the modules alphabetically listed by type, with links to the DFB definition and description.

Input/Output Processing

AW_AA: Analog Input Alarm Generation

AW_AIN: Analog Input Signal Conditioning

AW_AOUT: Analog Output Conversion

AW_AVERAGE: Process Variable Averaging

AW_DEADTIME120: Delay Input Variable by Specified Time (120 slots)

AW_DIN: Discrete Input Signal Conditioning

AW_INTERP40: Interpolate a Process Value

AW_KWH_MG: Calculate Energy Usage per Water Delivered

AW_MAP_AI8: Map 8-Channel Analog Input Card to Individual Tags

AW_MAP_AO4: Map Tags to 4-Channel Analog Output Card

AW_MAP_DI16: Map 16-Channel Discrete Input Card to Individual Tags

AW_MAP_DO16: Map Tags to 16-Channel Discrete Output Card

AW_MIN_MAX: Record Minimum and Maximum Process Value

AW_MOVAVG60: Process Variable Moving Average (60 Slots)

AW_MOVAVG600: Process Variable Moving Average (600 Slots)

AW_ON_OFF: Compare Process Variable to a Setpoint

AW_TOTAL: Flow Totalizer

AW_TOTALIZE: Daily and Monthly Flow Totalizer

Equipment Control

AW_ERR_CTRL: Control using Proportional/Integral Algorithm

AW_EXCESS_START: Monitor Equipment Excessive Number of Starts

AW_LDFLW3: Control Sequencing of up to Three Pumps

AW_MODE_CONTROL: Manage Operating Mode

AW_MODGATE: Control Operation of a Hydraulic Gate

AW_MODVLV: Control Operation of a Modulating Valve

AW_MOTOR: Control Operation of a Constant Speed Motor

AW_RT_STARTS: Accumulate Daily and Monthly Runtime and Starts

AW_RUNTIME: Accumulate Equipment Runtime and Starts

AW_SHORT_CYCLE: Inhibit Equipment Restart

AW_TRANSITIONS: Accumulate Valve Open Time and Transitions

AW_VALVE: Control Operation of a Two-State Valve

AW_VFD: Control Operation of a Variable Frequency Drive

Peer-to-Peer Communication

AW_READ_MBTCP: Read Data from Modbus-TCP Slave Device

AW_WRITE_MBTCP: Write Data to Modbus-TCP Slave Device

AW_GE_PQM – Extracts the data received from a Multilin PQM power monitoring device

AW_GE_SR469 – Extracts the data received from a Multilin 469 Motor Management Relay

AW_MULTILIN_CLOCK – Formats PLC Clock for Multilin Device Time Sync

PLC Monitoring

AW_CLOCK: PLC Clock Access

AW_GET_TOD: Reads the Current PLC Clock

AW_HEARTBEAT: Monitor a Heartbeat Register

AW_RESTART: Monitor PLC Startup

AW_SET_TOD: Updates the PLC Clock

Utilities

AW_MUTEX: Mutual Exclusion

AW_RADIO5: Select One of Five Inputs

AW_SCHEDULE: Schedule an Event based upon PLC Clock

AW_SEC_TO_TIME: Convert Seconds to TIME Format

AW_SP_TO_TIME: Convert Time Setpoints to Internal TIME Format

AW_TIME_REM: Calculate Time Remaining in Number of Seconds

AW_TIME_TO_ET: Convert Time to Hours, Minutes and Seconds

AW_TIME_TO_SEC: Convert TIME to number of Seconds

AW_TON_P: On Delay with Pause

PLC Migration

AW_ALIGN_DINT: Align Quantum DINT with X80 DINT Variable

AW_ALIGN_REAL: Align Quantum REAL with X80 REAL Variable

AW_ALIGN_UDINT: Align Quantum UDINT with X80 DINT Variable

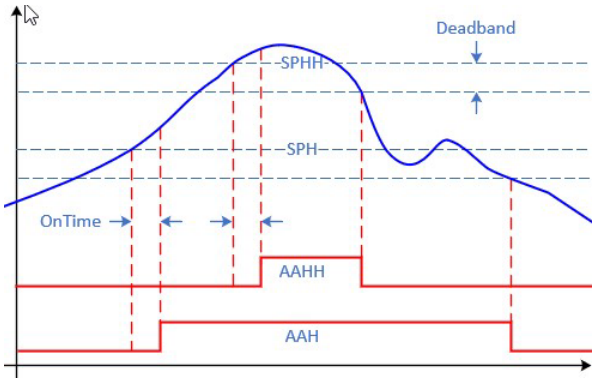
Installing the AW_ Family DFB Library

AW_AA: Analog Input Alarm Generation

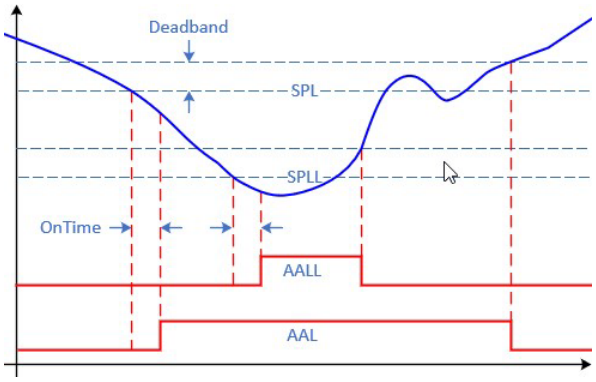
Function

Description

Compare a Process Variable (*PV*) to high and low alarm limits (*SPHH, SPH, SPL, and SPLL*). If the *PV* exceeds one of the alarm limits, the *OnTime* is activated. If the timer expires, then the associated alarm limit is activated.



The Low-Low and Low alarm limits operate in the opposite direction of the High-High and High limits.

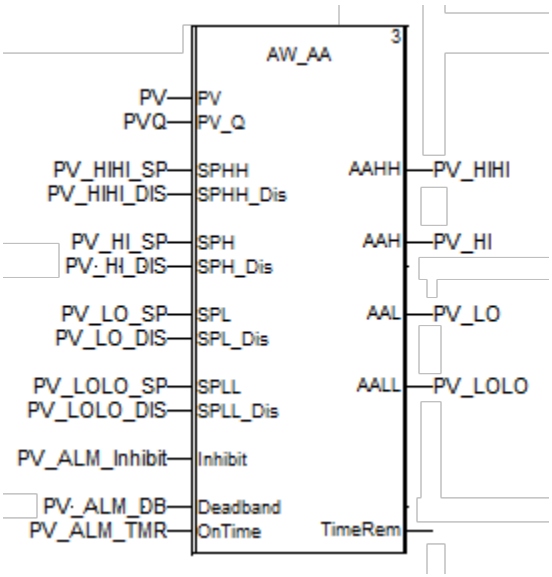


The *Deadband* parameter controls how much the *PV* must be above or below the setpoint to reset the alarm indication.

Each individual alarm limit can be enabled or disabled. A separate *Inhibit* function is provided to allow all checking to be suspended. This is typically used to disable alarming when the process is in a state where the parameter does not need to be checked, i.e. don't check discharge pressure when the pump is shut off.

Only Process Variables that have a good data quality will generate an alarm.

Representation



Parameter Description

Description of the input parameters:

Input Parameter	Type	Meaning
PV	REAL	Process Variable to be checked.
PV_Q	EBOOL	Process Variable data quality (1=Bad).
SPHH	REAL	High-High Alarm Limit.
SPHH_Dis	EBOOL	Set to disable High-High Alarm limit check (default = Enabled).
SPH	REAL	High Alarm Limit.
SPH_Dis	EBOOL	Set to disable High Alarm limit check (default = Enabled).
SPL	REAL	Low Alarm Limit.
SPL_Dis	EBOOL	Set to disable Low Alarm limit check (default = Enabled).
SPLL	REAL	Low-Low Alarm Limit.
SPLL_Dis	EBOOL	Set to disable Low-Low Alarm limit check (default = Enabled).
Inhibit	EBOOL	Set to inhibit all alarm limit checking (default = Enabled).
Deadband	REAL	Amount PV must go below the high limits, or above the low limits before the associated alarm indication is reset. (Default = 0.0).
OnTime	TIME	How long alarm condition must be active before output is set (Default = 1 sec).

Output Parameter	Type	Meaning
AAHH	EBOOL	Set when High-High Alarm conditions had been exceeded.
AAH	EBOOL	Set when High Alarm conditions had been exceeded.

Output Parameter	Type	Meaning
AAL	EBOOL	Set when Low Alarm conditions had been exceeded.
AALL	EBOOL	Set when Low-Low Alarm conditions had been exceeded.
TimeRem	UINT	Number of seconds before Alarm appears (sec)

Embedded Modules

AW_SEC_TO_TIME – Converts *OnTime* to internal TIME format.

AW_TIME_REM – Calculates number of seconds before alarm becomes active.

TON – Times how long until alarm limit is active.

Used By Modules

None

Top of the Document

AW_AIN: Analog Input Signal Conditioning

Function Description

This block converts a raw analog reading into engineering units using a linear conversion. The output is updated based upon the Update Rate. All good raw readings are averaged between updates. A PLC can scan a point several times a second (< 10ms). For most signals this is faster than necessary. Updating water flows every five seconds, or ambient temperatures minutely is typical. This helps stabilize the internal controls in the PLC that may be using these values. Since the HMIs are exception-based this reduces the processing that they must do. The update rate is specified on a point-by-point basis.

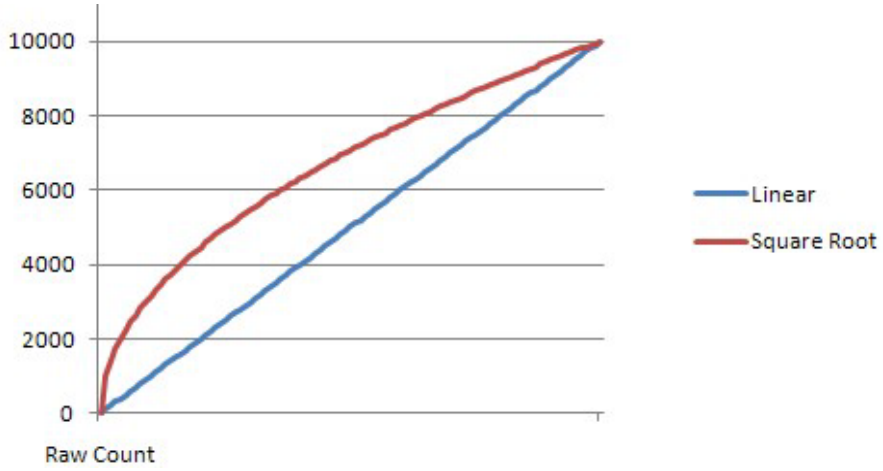
An additional feature to further reduce minor changes is the raw data dead-band. This value specifies the amount the average raw reading must change since the last update before a new value is calculated.

Some instrumentation has trouble providing values at the lower limits, such as positions and flows. These instruments may not reach exactly the low limit. When the live zero feature is enabled, the output value to be forced to the engineering low value for any valid reading below the specified zero limit.

A key attribute of every analog input is its associated data quality. The data quality is based upon the channel health provided by the input module. The channel health is set when the channel is operating normally and reset when it detects an error. The resulting output data quality is reset when the value is good, and it is set when it is bad. The option exists to maintain the last good reading when an error is detected. This is beneficial for the user to see what the value was before the fault occurred.

Manual Override is the ability to replace the field generated value with a manually entered one. Since scaling is being done at the controller, the substituted value will be in engineering units, not raw units. When a point is placed in manual override mode, the point's associated data quality is forced to be "Good". This capability allows the rest of the logic to operate on the manual value.

If the process instrument requires square-root linearization, it can be enabled by setting the *SqRoot* input. When enabled the raw input is adjusted before it is scaled:



Formula

$$AvgIn = \frac{\sum_{i=0}^{i=N} In_i}{N}$$

Explanation of the variables:

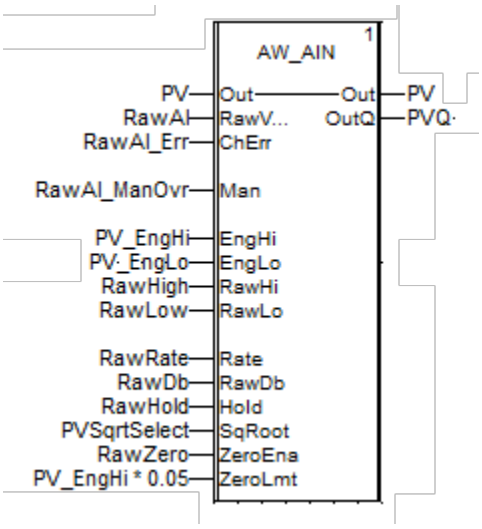
Variable	Description
AvgIn	Average of all good readings since last update
In_i	In value in current program cycle
N	Number of good samples between update period

$$Out = (AvgIn - RawLo) * \frac{EngHi - EngLo}{RawHi - RawLo} + EngLo$$

If Square-Root linearization is enabled, then the following formula is applied to the Input signal before the previous formula is used:

$$RawOut = \sqrt{\frac{RawIn - RawLo}{RawHi - RawLo}} * (RawHi\ - RawLo) + RawLo$$

Representation



Parameter Description

Input Parameter	Type	Meaning
In	INT	Raw Analog Input read from AI module.
ChErr	EBOOL	Associated Analog Input channel health. (1 = the channel has detected an error; 0 = the channel is operating normally).
Man	EBOOL	Set to allow output to be overwritten.
EngHi	REAL	Upper limit of scaled engineering unit output (default = 100.0).
EngLo	REAL	Lower limit of scaled engineering unit output (default = 0.0).
RawHi	INT	Upper limit of raw input (default = 20000). Needs to match the configured upper range of the AI channel.
RawLo	INT	Lower limit of raw input (default = 4000). Needs to match the configured lower range of the AI channel.
Rate	TIME	Update rate (default = 1 sec).
RawDb	INT	Raw data dead-band (default = 16).
Hold	EBOOL	Set to maintain last good reading (default = Hold).
SqRoot	EBOOL	Set to enable square-root linearization (default=Disable)
ZeroEna	EBOOL	Set to enable live zero detection (default = Enabled).
ZeroLmt	REAL	Live zero limit (default = 0.0).

Description of the input/output parameters:

Parameter	Type	Meaning
Out	REAL	Scaled Analog Input.

Output Parameter	Type	Meaning
OutQ	EBOOL	Scaled Analog Input Data Quality (1=Bad). Set if all the readings within the update period have a signal fault.

Embedded Modules

TON – Times between update periods.

Used By Modules None

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AW_AOUT: Analog Output Conversion

Function Description

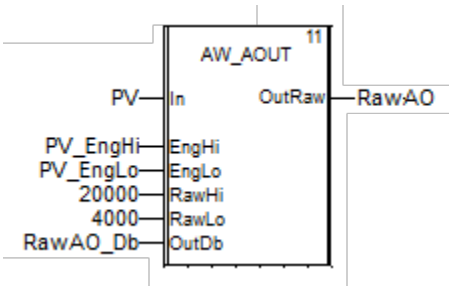
This block converts a process variable into raw counts using a linear conversion. The output is in a format necessary for use by the AO module.

The resulting conversion needs to differ by the output dead-band for the output to be updated.

Formula

$$OutRaw = (In - EngLo) * \frac{RawHi - RawLo}{EngHi - EngLo} + RawLo$$

Representation



Parameter Description

Input Parameter	Type	Meaning
In	REAL	Process variable to be output.
EngHi	REAL	Upper limit of scaled engineering unit input (default = 100.0).
EngLo	REAL	Lower limit of scaled engineering unit input (default = 0.0).
RawHi	INT	Upper limit of raw output (default = 20000). Needs to match the configured upper range of the AO channel.
RawLo	INT	Lower limit of raw output (default = 4000). Needs to match the configured lower range of the AO channel.
OutDb	INT	Raw data dead-band (default = 16).

Output Parameter	Type	Meaning
OutRaw	INT	Raw Analog Output for AO module.

Embedded Modules

None

Used By Modules

None

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AW_AVERAGE: Process Variable Averaging

Function Description

Calculate the average of the process variable between resets. The Average is updated every second. Only good readings are used. Must have at least one good reading for average to be good.

When a reset is processed, the current average is copied to the previous value before it is reset.

The facility to clear the Reset is provided, if needed.

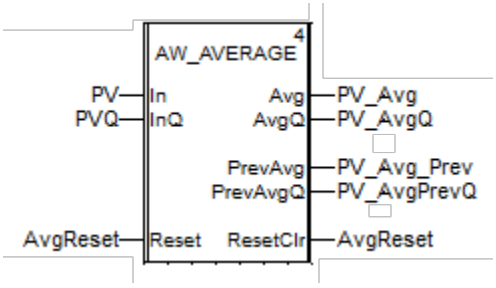
Formula

$$Avg = \frac{\sum_{i=0}^{i=N} In_i}{N}$$

Explanation of the variables:

Variable	Description
Avg	Average of all good readings since last reset
In_i	In value in current program cycle
N	Number of good samples between update period

Representation



Parameter Description

Input Parameter	Type	Meaning
In	REAL	Process Variable to average
InQ	EBOOL	Process Variable data quality (1 = Bad)
Reset	EBOOL	Set to copy current average to Previous Average and restart averaging (1 = Reset)

Output Parameter	Type	Meaning

Avg	REAL	Current Average since last Reset
AvgQ	EBOOL	Data quality of current Average (1 = Bad)
PrevAvg	REAL	Average at time of last Reset
PrevAvgQ	EBOOL	Data quality of Previous Average (1 = Bad)
ResetClr	EBOOL	Used to clear the Reset request

Embedded Modules

R_TRIG – Detects when *Reset* is set.

Used By Modules None

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AW_DEADTIME120: Delay Input Variable by Specified Time (120 slots)

Function Description

This function block delays an input signal by a specified time, the so-called deadtime. The function block delays the signal *In* by the deadtime *Duration* before it appears again at *Out*. It delays the input's value status, as well. The function block utilizes a 120-sample delay buffer to hold a sequence of *In* values. Each sample will be filled up based upon the *Duration* time. If the input value status goes bad during that period, then the value status for that sample will be marked as bad.

Whenever the system is started, the internal values are cleared, and their value statuses are all set to bad.

Formula

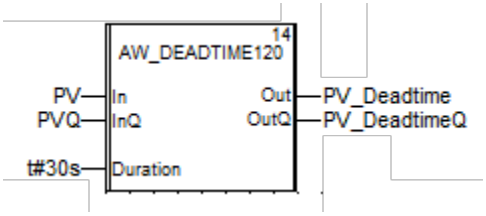
Each sample is filled based upon the duration time. For example:

$$Duration = 1\ minute$$

$$Samples = 120$$

$$Period = \frac{60\ seconds}{120\ slots} = 0.5\ \frac{sec}{slot}$$

Representation



Parameter Description

Input Parameter	Type	Meaning
In	REAL	Process Variable to delay.
InQ	BOOL	Process Variable Data Quality (1 = Bad) (Default: Good).
Duration	TIME	Duration to delay values (Minimum: 5 seconds) (Default: 1 hour).

Output Parameter	Type	Meaning
Out	REAL	Delayed Process Variable.
OutQ	EBOOL	Delayed Process Variable Data quality (1 = Bad).

Embedded Modules

SAMPLETM – Times between update periods.

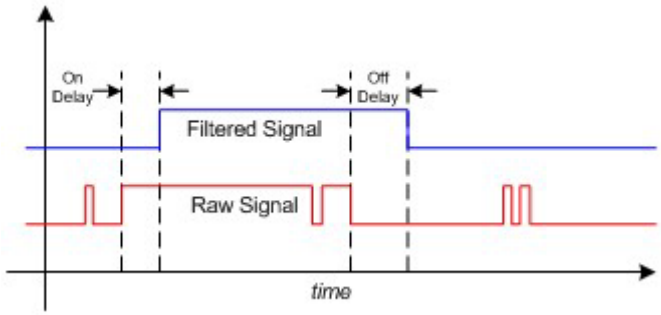
Used By Modules None

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AW_DIN: Discrete Input Signal Conditioning

Function Description

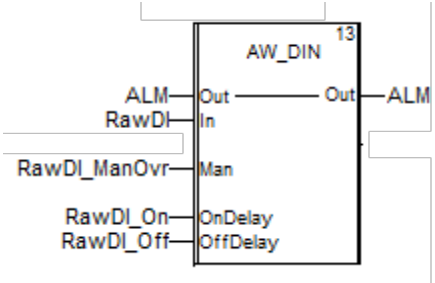
Discrete inputs need to be processed before being used by the rest of the logic. All discrete signals can to be buffered to avoid chatter on the output. This buffering is done by using a configurable delay time when the signal changes state. This forces the input to stay in the "set" state for the specified amount of time before it is propagated throughout the system. Once in the "set" state, it must return to the "reset" state for the configurable amount of time before the output signal is cleared. The On and Off delays are individually configured on a point by point basis. This will minimize the number of false indications generated by the system.



Manual Override is the ability to replace the field generated value with a manually entered one.

Providing this capability in the controller allows the rest of the logic to operate on the manual value.

Representation



Parameter Description

Input Parameter	Type	Meaning
In	EBOOL	Raw Discrete Input read from DI module.
Man	EBOOL	Set to allow output to be overwritten.
OnDelay	TIME	Amount of time input must be set before output is set (default = 100 ms).

OffDelay	TIME	Amount of time input must be reset before output is reset (default = 100 ms).

Output Parameter	Type	Meaning
Out	EBOOL	Processed Discrete Input.

Embedded Modules

SR – Maintains debounced indication.

TON – Debounces input transitions.

Used By Modules None

Top of the Document

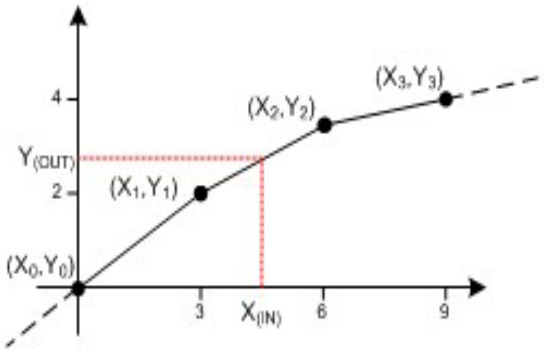
AW_INTERP40: Interpolate a Process Value

Function Description

This block interpolates or extrapolates an output reading based upon an analog input. The INTERP40 allows up to 40 pairs to be defined. The output value is calculated using a first order interpolation. If the input is outside the range of the interpolation points, then the output value is calculated by extrapolating the value using the coordinates at the end of the *XY* table. The *X* values must be in ascending order.

The data quality of the output is determined by combining the data quality of the input value, and the data quality of the *X* and *Y* pairs used to calculate the output. If the input value has a bad data quality, then the last good reading is used, but the resulting data quality is set to bad.

For example, using the following set of coordinates:



XY	Value	Coordinate
0	0.0	X_0
1	0.0	Y_0
2	3.0	X_1
3	2.0	Y_1
4	6.0	X_2
5	3.5	Y_2
6	9.0	X_3
7	4.0	Y_3

The resulting outputs are generated based upon the previous table:

In	Out
-3.0	-2.0
4.5	2.75
12.0	5.5

Formula

If the input value (*In*) is between two pairs of coordinates, then the output (Out) is interpolated between the two pairs.

$$Out = (In - X_i) * \frac{(Y_{i+1} - Y_i)}{(X_{i+1} - X_i)} + Y_i$$

Where i is the designator for the lower coordinate pair.

If the input value is outside the range, then the output is extrapolated based upon the closest coordinate pair. If it is below the lower coordinate pair, then the formula is:

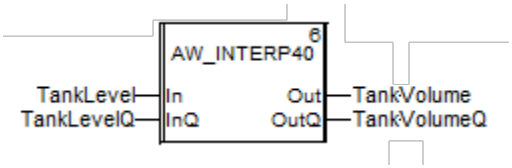
$$Out = (In - X_0) * \frac{(Y_1 - Y_0)}{(X_1 - X_0)} + Y_0$$

If it is above the last coordinate pair, then the formula is:

$$Out = (In - X_{38}) * \frac{(Y_{39} - Y_{38})}{(X_{39} - X_{38})} + Y_{38}$$

Where L is the designator for the last coordinate pair.

Representation



Parameter Description

Input Parameter	Type	Meaning
In	REAL	Process Variable to be converted.
InQ	BOOL	Process Variable data quality (1=Bad).

Output Parameter	Type	Meaning
Out	REAL	Converted value.
OutQ	EBOOL	Converted data quality (1=Bad).

Description of the public parameters:

Parameter	Type	Meaning
XY	ARRAY[0..79] OF REAL	Array of X/Y coordinates for interpolation table. The odd indices are the X values, and the even indices are the Y values, i.e. XY[0] = X0, XY[1] = Y0, XY[2] = X1, XY[3] = Y1, etc. Note: When entering the values into this table X(i) and X(i+1) cannot be the same value or a bad data quality will be assigned to the output.

Parameter	Type	Meaning
Q	ARRAY[0..79] OF BOOL	Array of data qualities associated with each X/Y coordinate. These values, in addition to the input data quality, are used to determine the resulting data quality of the output value. (1=Bad). By default, the data qualities are assumed to be good. (0=Good).
LastNum	UINT	Last used array index (must be an odd number and greater than 2). Used to limit the size of the interpolation table to be searched. Care must be taken when setting this parameter. If set incorrectly, then the module will not operate properly.

Embedded Modules

None

Used By Modules None

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AW_KWH_MG: Calculate Energy Usage per Millions of Gallons

Function Description

Calculates the Energy Used to deliver a Million Gallons of water. Calculations are done for the current day, previous day, current month and previous month.

The input values are typically provided by the AW_TOTALIZE and the AW_GE_PGM modules.

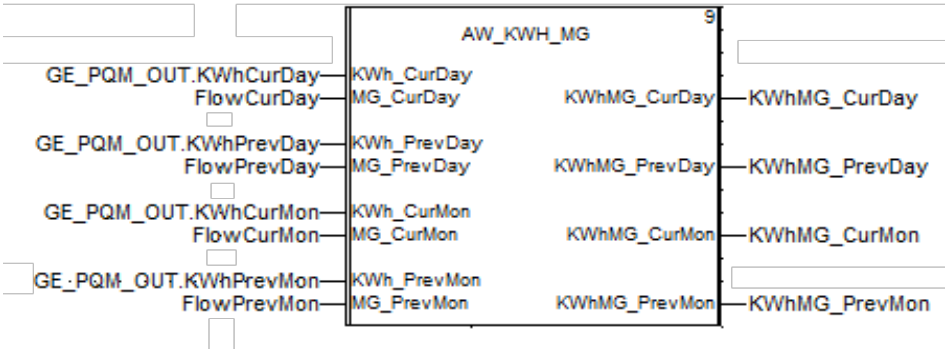
Formula

$$KWhMG = \frac{KWh}{MG}$$

Explanation of the variables:

Variable	Description
KWhMG	Calculated Energy Usage per Million Gallons of Water.
KWh	Energy Used for each period in KWh.
MG	Volume of Water delivered in MG.

Representation



Parameter Description

Parameter	Type	Meaning
KWh_CurDay	REAL	Current Day Energy Used (KWh)
MG_CurDay	REAL	Current Day Water Volume (MG)
KWh_PrevDay	REAL	Previous Day Energy Used (KWh)
MG_PrevDay	REAL	Previous Day Water Volume (MG)
KWh_CurMon	REAL	Current Month Energy Used (KWh)
MG_CurMon	REAL	Current Month Water Volume (MG)
KWh_PrevMon	REAL	Previous Month Energy Used (KWh)
MG_PrevMon	REAL	Previous Month Water Volume (MG)

Output Parameter	Type	Meaning
KWhMG_CurDay	REAL	Current Day Energy Used per Water Volume (KWh/MG)
KWhMG_PrevDay	REAL	Previous Day Energy Used per Water Volume (KWh/MG)
KWhMG_CurMon	REAL	Current Month Energy Used per Water Volume (KWh/MG)
KWhMG_PrevMon	REAL	Previous Month Energy Used per Water Volume (KWh/MG)

Embedded Modules

None.

Used By Modules None.

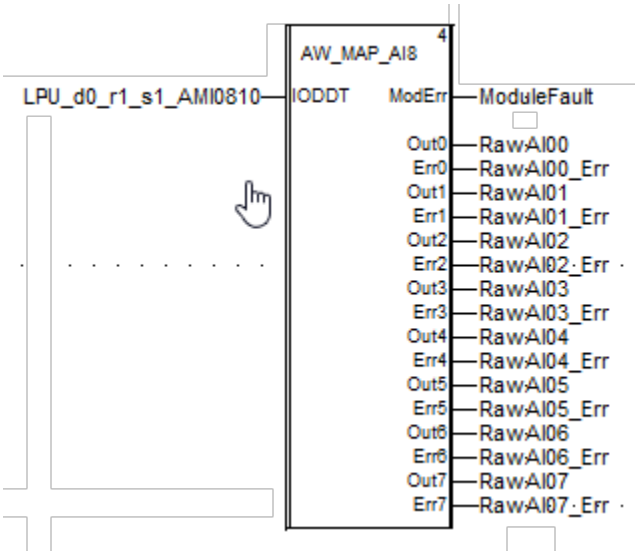
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AW_MAP_AI8: Map 8-Channel Analog Input Card to Individual Tags

Function Description

Extracts Individual Channel information from an 8-channel Analog Input Module IODDT into separate tags for further processing by the logic. In addition, it normalizes the channel health so that all faults are a set state.

Representation



Parameter Description

Input Parameter	Type	Meaning
IODDT	T_U_ANA_STD_IN_8	Standard 8-Channel Analog Input IODDT

Output Parameter	Type	Meaning
ModErr	BOOL	Module Status (1=Fault)
Out0 – Out7	INT	Individual Channel Values
Err0 – Err7	BOOL	Individual Channel Statuses (1=Bad)

Embedded Modules

None

Used By Modules None

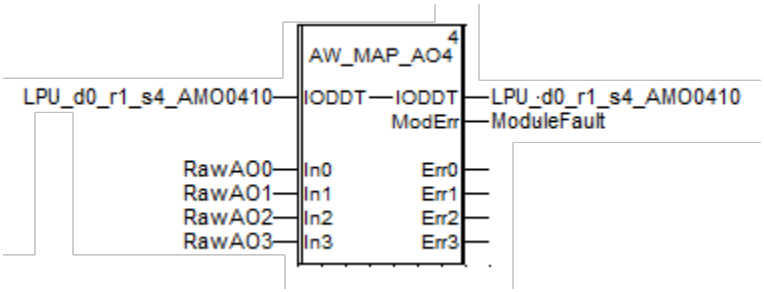
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AW_MAP_AO4: Map Tags to 4-Channel Analog Output Card

Function Description

Copies separate tags to the Individual Channel information of a 4-Channel Analog Output Module IODDT. In addition, it normalizes the module and channel health so that all faults are a set state.

Representation



Parameter Description

Input Parameter	Type	Meaning
IODDT	T_U_ANA_STD_OUT_4	Standard 4-Channel Analog Output IODDT
In0 – In3	INT	Individual Channel Values

Output Parameter	Type	Meaning
ModErr	BOOL	Module Status (1=Fault)
Err0 – Err3	BOOL	Individual Channel Broken Loop Indications (1=Fault)

Embedded Modules

None

Used By Modules None

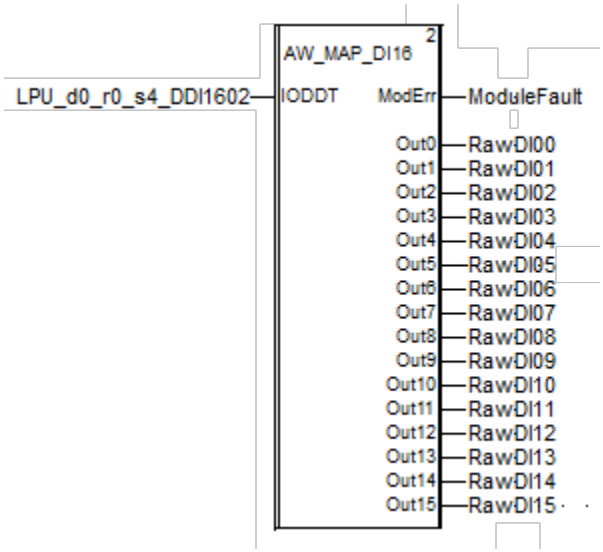
Top of the Document

AW_MAP_DI16: Map 16-Channel Discrete Input Card to Individual Tags

Function Description

Extracts Individual Channel information from a 16-Channel Discrete Input Module IODDT into separate tags for further processing by the logic. In addition, it normalizes the module health so that all faults are a set state.

Representation



Parameter Description

Input Parameter	Type	Meaning
IODDT	T_U_DIS_STD_IN_16	Standard 16-Channel Discrete Input IODDT

Output Parameter	Type	Meaning
ModErr	BOOL	Module Status (1=Fault)
Out0 – Out15	EBOOL	Individual Channel Values

Embedded Modules

None

Used By Modules None

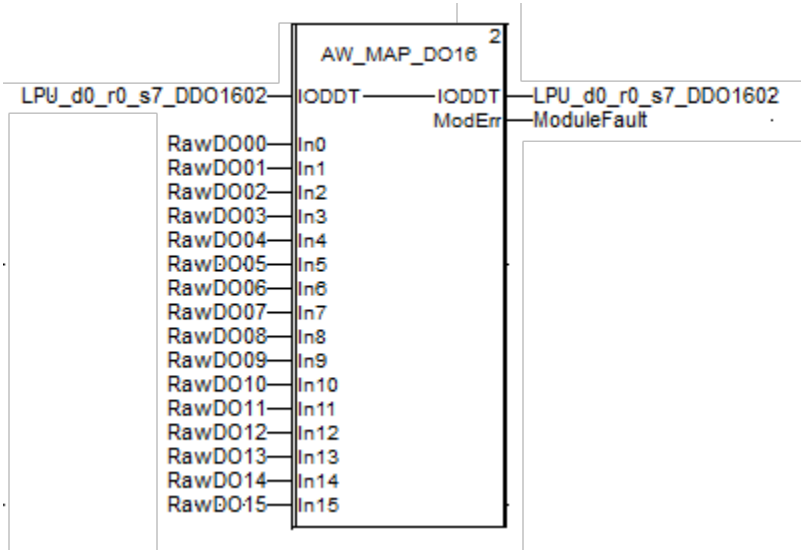
Top of the Document

AW_MAP_DO16: Map Tags to 16-Channel Discrete Output Card

Function Description

Copies separate tags to the Individual Channel information of a 16-Channel Discrete Output Module IODDT. In addition, it normalizes the that all faults are a set state.

Representation



Parameter Description

Input Parameter	Type	Meaning
IODDT	T_U_DIS_STD_OUT_16	Standard 16-Channel Discrete Output IODDT
In0 – In15	EBOOL	Individual Channel Values

Output Parameter	Type	Meaning
ModErr	BOOL	Module Status (1=Fault)

Embedded Modules

None

Used By Modules None

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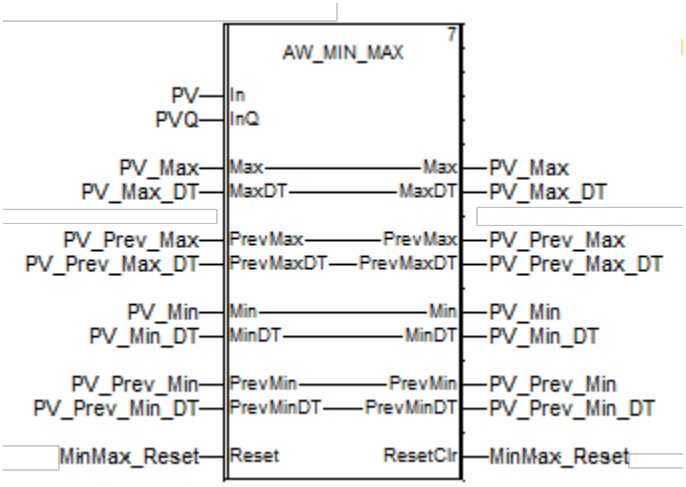
AW_MIN_MAX: Record Minimum and Maximum Process Value

Function Description

Captures the Minimum and Maximum value since last reset. Only good values are checked. The date and time the Minimum or Maximum are recorded each time the readings are updated.

The facility to clear the Reset is provided, if needed.

Representation



Parameter Description

Input Parameter	Type	Meaning
In	REAL	Process variable to be monitored.
InQ	EBOOL	Process Variable data quality (1 = Bad).
Reset	EBOOL	Set to reset minimum and maximum readings (1 = Reset)

Parameter	Type	Meaning
Max	REAL	Maximum reading since last reset.
MaxDT	DATE_TIME	Date and time the Maximum reading occurred.
PrevMax	REAL	Previous Maximum reading.
PrevMaxDT	DATE_TIME	Date and time the Previous Maximum occurred.
Min	REAL	Minimum reading since last reset.
MinDT	DATE_TIME	Date and time the Minimum reading occurred.
PrevMin	REAL	Previous Minimum reading.
PrevMinDT	DATE_TIME	Date and time the Previous Minimum occurred.

Output Parameter	Type	Meaning
ResetClr	EBOOL	Used to clear the Reset request.

DATE_TIME Description

Data structure parameters:

Element	Data Type	Meaning
Year	UINT	Year (2000 – 2099).
Month	UINT	Month (1 – 12).
Day	UINT	Day (1 – 31).
Hour	UINT	Hour (0 – 23).
Minute	UINT	Minute (0 – 59).
Second	UINT	Second (0 – 59).

Embedded Modules

AW_GET_TOD – Records date and time Minimum or Maximum occurred.

Used By Modules None

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AW_MOVAVG60: Process Variable Moving Average (60 Slots)

Function Description

This block calculates a moving average over a specified duration. The average is calculated using a series of 60 samples. Each sample consists of the average of the update readings during that sample period. The sample period is determined by dividing the *Duration* by the number of samples. Each sample will contain the average of all the good readings during that period. Not recommended for durations longer than 10 minutes due to sample period getting too large. For longer durations, use the MOVAVG600 module.

The good and bad readings will be tracked. On initialization of the block, all the data in the *ReadingsQ* array will be set bad. The average will be considered bad until the percentage of good readings meets or exceeds the percentage specified.

Formula

$$Avg = \frac{\sum_{x=1}^{x=60} Sample[x]}{60 * Scale}$$

Explanation of the variables:

Variable	Description
Avg	Average of all samples updated at end of each sample period.
Sample[x]	Average of good samples for that period of time, where *x* is the slot index.
Scale	Scale factor.

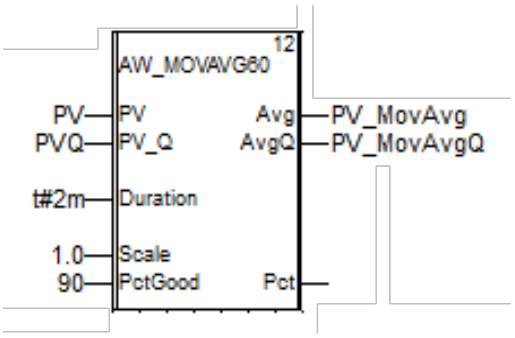
Each sample is filled based upon the duration time. For example:

$Duration = 1\ minute$

$Samples = 60$

$$Period = \frac{60\ seconds}{60\ slots} = 1\ \frac{sec}{slot}$$

Representation



Parameter Description

Input Parameter	Type	Meaning
PV	REAL	Process Variable to average.
PV_Q	BOOL	Process Variable Data Quality (1 = Bad) (Default: Good).
Duration	TIME	Duration to average values (Minimum: 5 seconds) (Default: 1 minute).
Scale	REAL	Scale Factor (Avg = MovAvg / Scale) (Default: 1.0).
PctGood	DINT	Minimum Percentage of readings that must be good for average to be good. (Default: 80).

Output Parameter	Type	Meaning
Avg	REAL	Current Average since last Reset.
AvgQ	EBOOL	Data quality of current Average (1 = Bad).
Pct	DINT	Actual percentage good.

Embedded Modules

SAMPLETM – Times between updates.

Used By Modules None.

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AW_MOVAVG600: Process Variable Moving Average (600 Slots)

Function Description

This block calculates a moving average over a specified duration. The average is calculated using a series of 600 samples. Each sample consists of the average of the update readings during that sample period. The sample period is determined by dividing the *Duration* by the number of samples. Each sample will contain the average of all the good readings during that period. Not recommended for durations shorter than 1 minute due to sample period getting too small. For shorter durations, use the MOVAVG60 module.

The good and bad readings will be tracked. On initialization of the block, all the data in the *ReadingsQ* array will be set bad. The average will be considered bad until the percentage of good readings meets or exceeds the percentage specified.

Formula

$$Avg = \frac{\sum_{x=1}^{x=600} Sample[x]}{600 * Scale}$$

Explanation of the variables:

Variable	Description
Avg	Average of all samples updated at end of each sample period.
Sample[x]	Average of good samples for that period of time, where *x* is the slot index.
Scale	Scale factor.

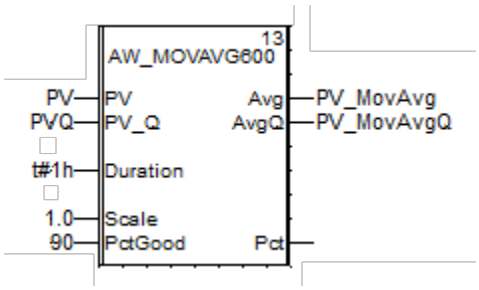
Each sample is filled based upon the duration time. For example:

$Duration = 1\ hour\ (3600\ seconds)$

$Samples = 600$

$$Period = \frac{3600\ seconds}{600\ slots} = 6\ \frac{sec}{slot}$$

Representation



Parameter Description

Input Parameter	Type	Meaning
PV	REAL	Process Variable to average.
PV_Q	BOOL	Process Variable Data Quality (1 = Bad) (Default: Good).
Duration	TIME	Duration to average values (Minimum: 1 minute) (Default: 1 hour).
Scale	REAL	Scale Factor (Avg = MovAvg / Scale) (Default: 1.0).
PctGood	DINT	Minimum Percentage of readings that must be good for average to be good. (Default: 80).

Output Parameter	Type	Meaning
Avg	REAL	Current Average since last Reset.
AvgQ	EBOOL	Data quality of current Average (1 = Bad).
Pct	DINT	Actual percentage good.

Embedded Modules

SAMPLETM – Times between updates.

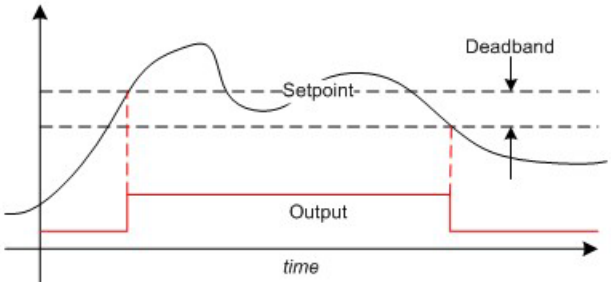
Used By Modules None.

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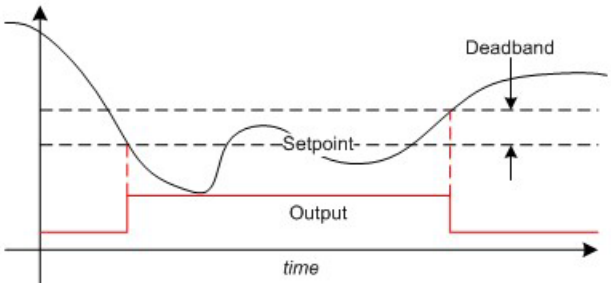
AW_ON_OFF: Compare Process Variable to a Setpoint

Function Description

Compare a Process Variable (*PV*) to a Setpoint (*SP*). If the *PV* is greater, then the Output (*Out*) is set. If the *PV* is less than the *SP*, then *Out* is reset.



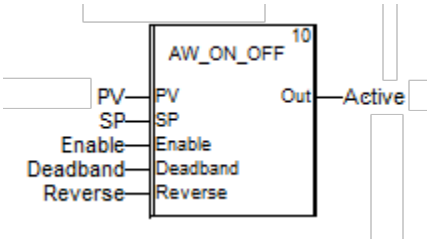
You can reverse the mode of operation by setting the *Reverse* parameter. If *Reverse* is set, then *Out* is set if *PV* is less than *SP* and reset *PV* is greater than *SP*.



The *Deadband* parameter controls how much the *PV* must be above or below the *SP* to reset *Out*.

Differs from Unity COMP_DB DFB in that it checks in only one direction, not both above and below the setpoint.

Representation



Parameter Description

Input Parameter	Type	Meaning
PV	REAL	Process Variable to check.
SP	REAL	Setpoint to compare *PV* with.
Enable	BOOL	Set when checking is to be performed (default=True)
Deadband	REAL	Amount *PV* must go above *SP* if *Reverse* is set, or go below *SP* is *Reverse* is reset, before the output is reset. (Default: 0.0)
Reverse	REAL	Controls whether PV must be above or below the *SP* to set the output. (1=*PV* < *SP*,0=*PV* > *SP*) (Default: *PV* > *SP*)

Output Parameter	Type	Meaning
Out	BOOL	Set when PV is less than SP, if Reverse is Set, otherwise it is set when PV is greater than SP.

Embedded Modules

None.

Used By Modules None.

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AW_TOTAL: Flow Totalizer

Function Description

Totalize a process variable. The totalized running total is obtained by summing up the process variable, which is weighted by the scaling factor. The samples are averaged between the update *Period*. *Scale* is used to convert integrated rate to total, i.e. to convert MGD to MG sampled every minute would be 1440 (60 min * 24 hr). Only good readings are totalized (PVQ = False).

The *CurTot* is maintained until a reset signal is received. The module is provided with a *ResetClr* output that can be used to clear the *Reset* request after the reset has been performed, if desired.

When a reset request is detected, the current total, and its quality, are transferred to the *PrevTot* and *PrevTotQ* outputs, and the *CurTot* is reset.

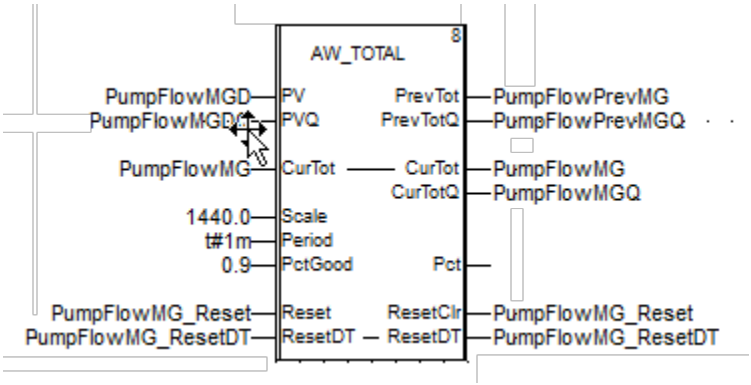
Formula

$$CurTot = CurTot_{prev} + \frac{PV_{avg}}{Scale}$$

Explanation of the variables:

Variable	Description
CurTot	Updated current total.
CurTotprev	Previous total.
PVavg	Average of good Process Variable readings since last update.
Scale	Scaling factor.

Representation



Parameter Description

Input Parameter	Type	Meaning
PV	REAL	Process Variable to be totalized.
PVQ	EBOOL	Value status of process variable. (1=Bad, 0=Good) (Default: Good)
Scale	REAL	Scaling factor to apply to periodic sample. (Default: 1.0)
Period	TIME	How often to update the total. Process variable is averaged between update periods. (Default: 1 minute)
PctGood	REAL	Percent of totalized values that must be good for current total to be good. (1.0 = 100%, 0.5 = 50%) (Default: 100%)
Reset	EBOOL	Request reset of totalized value. Transfers current total to previous value and clears current total.

Description of the input/output parameters:

Parameter	Type	Meaning
CurTot	REAL	Current totalized value.
ResetDT	DATE_TIME	Date and Time the reset was performed.

Output Parameter	Type	Meaning
PrevTot	REAL	Previous totalized value accumulated before reset signal.
PrevTotQ	EBOOL	Previous totalized value data quality. (1=Bad)
CurTotQ	EBOOL	Current totalized value data quality. (1=Bad)
Pct	REAL	Current percentage of totalized values that are good (1 = 100%)
ResetClr	EBOOL	Used to clear reset signal. Typically assigned to Reset parameter.

DATE_TIME Description

Data structure parameters:

Element	Data Type	Meaning
Year	UINT	Year (2000 – 2099)
Month	UINT	Month (1 – 12)
Day	UINT	Day (1 – 31)
Hour	UINT	Hour (0 – 23)
Minute	UINT	Minute (0 – 59)
Second	UINT	Second (0 – 59)

Embedded Modules

AW_GET_TOD – Reads date and time when reset.

R_TRIG – Detects when *Reset* is set.

SAMPLETM – Times between updates.

Used By Modules

None.

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AW_TOTALIZE: Flow Totalizer, Daily and Monthly Flow Totals

Function Description

Totalize a process variable. The totalized running total is obtained by summing up the process variable, which is weighted by the scaling factor. The samples are averaged between the update *Period*. *Scale* is used to convert integrated rate to total, i.e. to convert MGD to MG sampled every minute would be 1440 (60 min * 24 hr). Only good readings are totalized (PVQ = False).

The *CurTot* is maintained for the current day and month.

When a daily or monthly reset is processed, the current totals, and their quality, are transferred to the previous outputs.

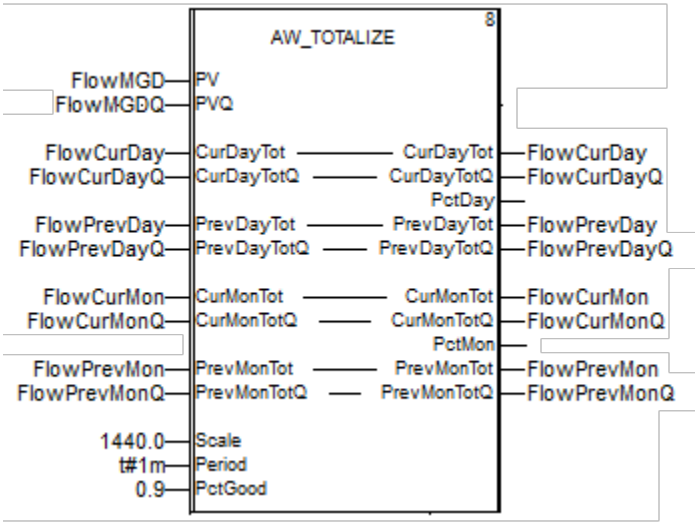
Formula

$$CurTot = CurTot_{prev} + \frac{PV_{avg}}{Scale}$$

Explanation of the variables:

Variable	Description
CurTot	Updated current total.
CurTotprev	Previous total.
PVavg	Average of good Process Variable readings since last update.
Scale	Scaling factor.

Representation



Parameter Description

Input Parameter	Type	Meaning
PV	REAL	Process Variable to be totalized.
PVQ	EBOOL	Value status of process variable. (1=Bad, 0=Good) (Default: Good)
Scale	REAL	Scaling factor to apply to periodic sample. (Default: 1.0)
Period	TIME	How often to update the total. Process variable is averaged between update periods. (Default: 1 minute)
PctGood	REAL	Percent of totalized values that must be good for current total to be good. (1.0 = 100%, 0.5 = 50%) (Default: 100%)

Parameter	Type	Meaning
CurDayTot	REAL	Current day totalized value.
CurDayTotQ	EBOOL	Current day totalized value data quality. (1=Bad)
PrevDayTot	REAL	Previous day totalized value accumulated before reset signal.
PrevDayTotQ	EBOOL	Previous day totalized value data quality. (1=Bad)
CurMonTot	REAL	Current month totalized value.
CurMonTotQ	EBOOL	Current month totalized value data quality. (1=Bad)
PrevMonTot	REAL	Previous month totalized value accumulated before reset signal.
PrevMonTotQ	EBOOL	Previous month totalized value data quality. (1=Bad)

Output Parameter	Type	Meaning
PctDay	REAL	Current percentage of today's totalized values that are good (1 = 100%)
PctMon	REAL	Current percentage of this month's totalized values that are good (1 = 100%)

Embedded Modules

AW_GET_TOD – Reads date and time to reset daily and monthly values.

R_TRIG – Detects beginning of day and month.

SAMPLETM – Times between updates.

Used By Modules None.

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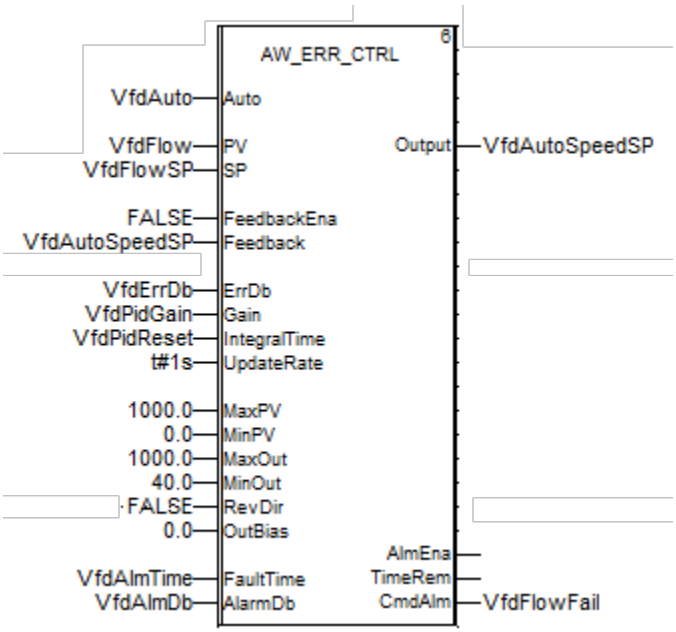
AW_ERR_CTRL: Control using Proportional/Integral Algorithm

Function Description

Compare the process variable (*PV*) to the setpoint (*SP*) in order to determine the desired actuator position (*Output*). The standard control module, *PI_B*, does the actual control. It has been encapsulated in this module to facilitate parameter loading and add error handling. See the online help for greater detail on how the *PI_B* module works and how to configure it.

Error checking does not begin until the output reaches either the maximum (*MaxOut*) or minimum (*MinOut*) value. At that time the fault timer (*FaultTime*) starts timing, and if the process variable is not within the alarm deadband (*AlmDb*) when it expires, then an alarm is generated (*CmdAlm*).

Representation



Parameter Description

Description of the input parameters:

Input Parameter	Type	Meaning
Auto	EBOOL	Operating Mode (1 = Auto, 0 = Manual).
PV	REAL	Process Variable being controlled.
SP	REAL	Process Setpoint.
FeedbackEna	BOOL	If set, then use Feedback, else use open-loop control (Default: open-loop).
Feedback	REAL	Current actuator position.
ErrDb	REAL	How close to control Process Variable to the Setpoint (Default: 1.0)
Gain	REAL	Proportional contribution (kp) (Default: 0.0)
IntegralTime	UINT	Integral time (ti) (Default: 10 sec)
UpdateRate	TIME	Update rate of the PI controller (Default: 1 sec)
MaxPV	REAL	Upper limit of the process variable range (Default: 100.0)
MinPV	REAL	Lower limit of the process variable range (Default: 0.0)
MaxOut	REAL	Upper limit of the output value range (Default: 100.0)
MinOut	REAL	Lower limit of the output value range (Default: 0.0)
RevDir	BOOL	If set, then PI module operates in an opposite direction, else it is direct acting (Default: direct acting)
OutBias	REAL	Manual adjustment of the static deviation (Default: 0.0)
FaultTime	UINT	Time (in sec) allowed before an alarm is generated once output reaches *MaxOut* or *MinOut*. (default: 10 sec)
AlarmDb	REAL	How close process variable needs to be to the setpoint to disable alarm checking (Default: 2.0)

Output Parameter	Type	Meaning
Output	REAL	Desired actuator position.
AlmEna	EBOOL	Set when alarm checking is active.
TimeRem	UINT	Time (in sec) before an alarm is generated.
CmdAlm	EBOOL	Set if process variable is not within *AlmDb* once *MaxOut* or *MinOut* is reached and *FaultTime* has expired.

Embedded Modules

AW_SEC_TO_TIME – Converts *IntegralTime* and *FaultTime* to internal TIME formats.

AW_TIME_REM – Calculates time remaining until fault occurs.

COMP_DB – Checks if *PV* and *SP* are within the specified alarm deadband.

Para_PI_B – Loads specified parameters into data block for PI_B DFB.

PI_B – Performs the Proportional/Integral control.

SAMPLETM – Controls the update rate of the PI_B module.

TON – Times Fault Time.

Used By Modules None

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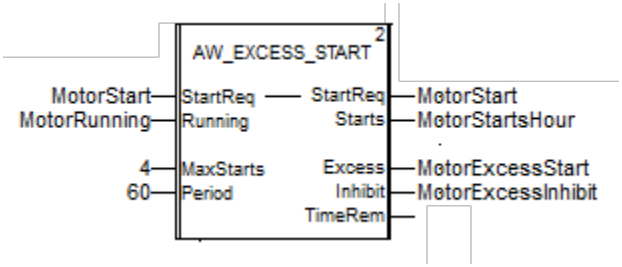
AW_EXCESS_START: Monitor Equipment Excessive Number of Starts

Function Description

Some equipment needs to be limited in how often they can be started. This module detects each time the equipment starts and counts the number of occurrences within the period of time specified. The period of time (*Period*) is a moving window, so that the number of starts is not based upon a specific start time, but a duration of time. For example, if a pump is configured to limit starting twice an hour, the module will generate an *Inhibit* signal once the specified number of starts has been reached, and the *Excess* signal once it has been exceeded. The *TimeRem* output provides a countdown timer (in seconds) until another start can performed without generating an *Excess* alarm.

The module can be used to clear the equipment start request when the inhibit level is reached to avoid reaching the *Excess* alarm. It is designed to work as a front-end to a MOTOR or VFD module.

Representation



Parameter Description

Input Parameter	Type	Meaning
Running	EBOOL	Running indication of the equipment (1=Running)
MaxStarts	UINT	Maximum number of starts permitted in the period of time specified. (Default = 2)
Period	UINT	The period of time to monitor the number of starts. (Default = 60 minutes)

Output Parameter	Type	Meaning
Starts	UINT	The current number of starts detected within the period of time specified.
Excess	EBOOL	Set when the number of starts in the period of time has been exceeded.
Inhibit	EBOOL	Set when the number of starts has been reached, and another start should not be performed.

Output Parameter	Type	Meaning
TimeRem	UINT	The number of seconds before another start is allowed.

Parameter	Type	Meaning
StartReq	EBOOL	Used to clear the start request when the Inhibit level has been reached.

Embedded Modules

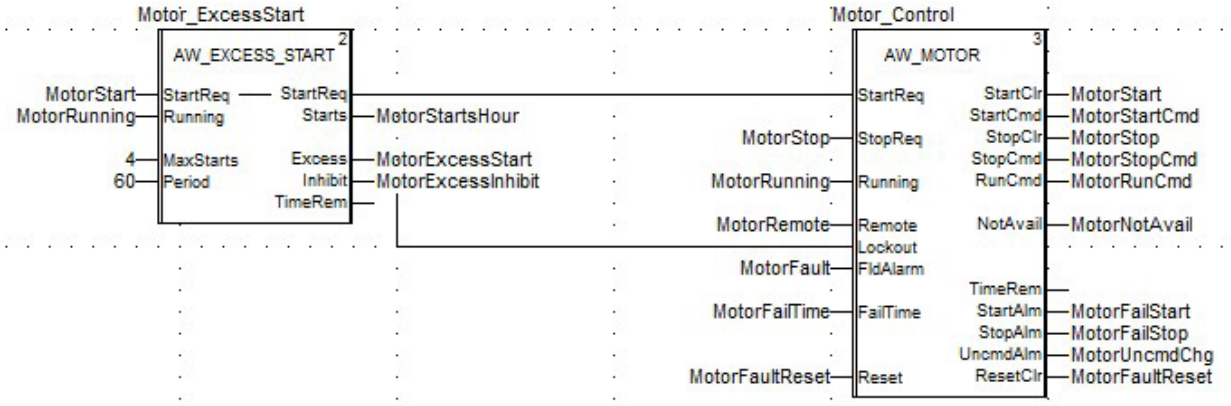
R_TRIG – Detects when motor starts.

SAMPLETM – Pulses every second.

Used By Modules

None

Sample Code

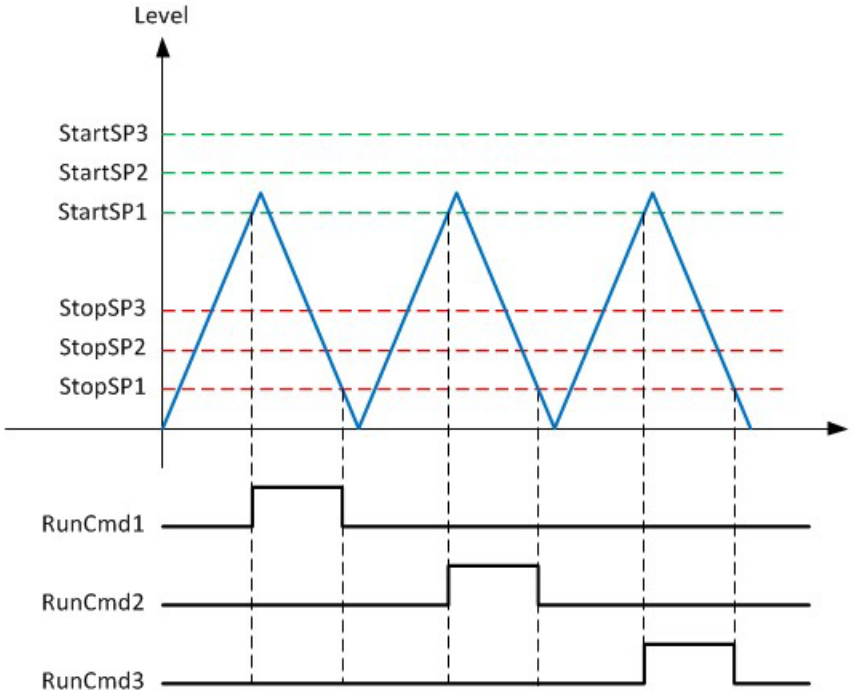


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AW_LDFLW3: Control Sequencing of up to Three Pumps

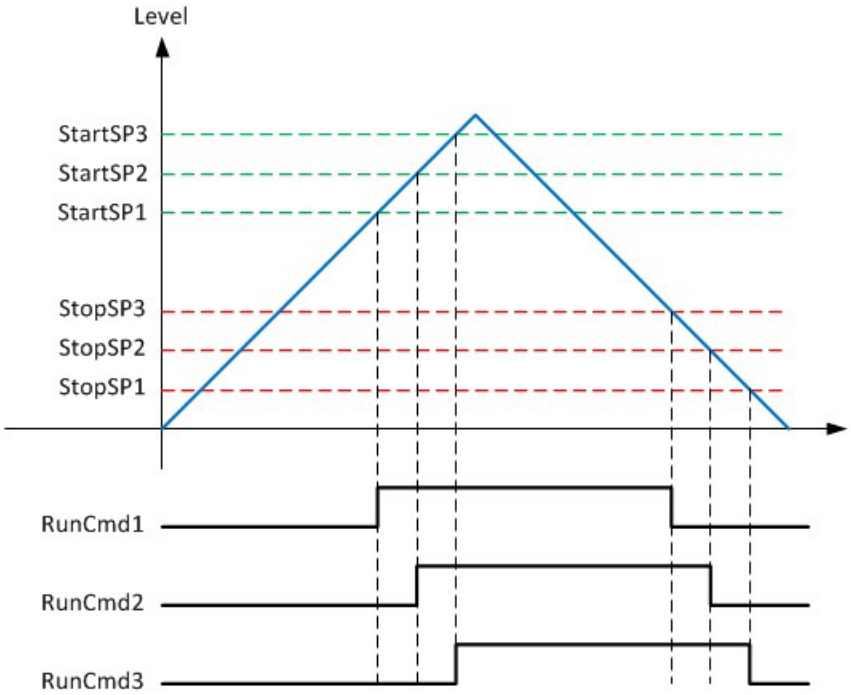
Function Description

The Lead-Follow module controls the operation of up to three pumps based upon the process *Level*. The pumps can be used to either fill or drain the tank based upon the setting of the *Fill* parameter. When set, it is assumed starting a pump will increase the *Level*, whereas if it is reset, starting a pump should decrease the *Level*. The module rotates which pump is started next each time it stops a pump. This function attempts to spread the operation of the pumps equally across all the pumps. The pump sequence (*Seq1*, *Seq2* and *Seq3*) indicates the order the pumps will be started.



Each time the lowest start setpoint is reached (Drain mode assumed) a pump is started. It will run until the lowest stop setpoint is reached (Note: *Start* and *Stop* setpoints are labeled 1 thru 3, but the order is independent of the order they are processed or the pumps). The pump chosen to be started is based upon which one had not been started most recently.

If a single pump cannot keep up with the demand, and the next start setpoint is reached, then the next available pump will be started. This continues until all the pumps are running.



When multiple pumps are running, the pumps are stopped based upon which pump was running the longest.

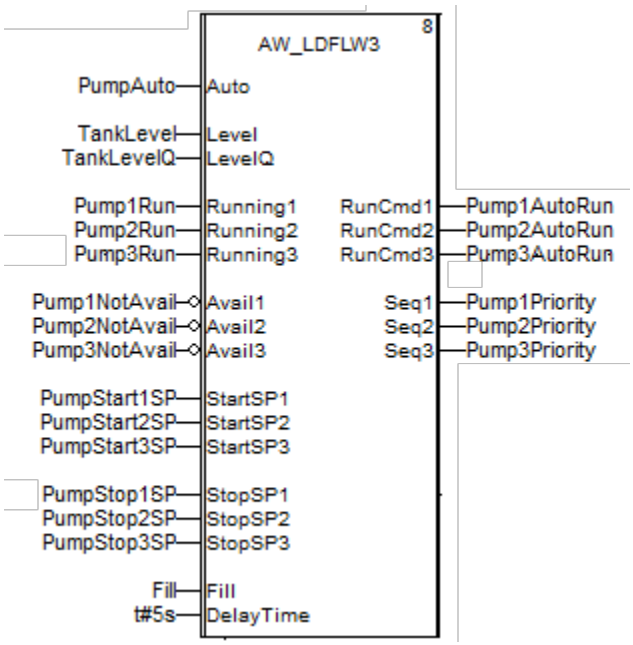
If a pump becomes unavailable or fails to start, then the next available pump will take its place in the sequence.

If the module is not in auto mode, then the run commands track the current running state of the pumps to provide a bumpless transfer when changing modes. The running state of all the pumps is used to determine how many pumps should be running, even if they are not under the control of the module.

If the module determines that multiple pumps must be started at the same time, it provides a delay (*DelayTime*) between each start.

The module monitors the status of the data quality of the controlling level. If the level fails, the module suspends the sequencing of the pumps, and maintains their current state. When the level is restored, the sequencing will continue.

Representation



Parameter Description

Input Parameter	Type	Meaning
Level	REAL	Process Level used to control pumps
LevelQ	EBOOL	Process Level Data Quality (1=Bad) (Default=Good). Quality must be good for pump sequencing to occur.
StartSP1,2,3	REAL	Pump Start Setpoints
StopSP1,2,3	REAL	Pump Stop Setpoints
Running1,2,3	EBOOL	Pump Running Indications (1=Running) (Default=Stopped)
Avail1,2,3	EBOOL	Pump Available for Auto Control (1=Available) (Default=Unavailable). Only available pumps are controlled.
Fill	BOOL	Controls whether the pumps are filling or draining the tank (1=Fill,0=Drain) (Default=Drain)
DelayTime	TIME	Minimum Delay between Pump Starts (Default=5 sec)

Output Parameter	Type	Meaning
RunCmd1,2,3	EBOOL	Pump Run Commands (1 = Run).
Seq1,2,3	UINT	Start Sequence (0 = N/A, 1 = Lead, 2-3 = Lag Order).

Embedded Modules

F_TRIG – Detects when one of the pumps stop.

R_TRIG – Detects when one of the pumps start.

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TON – Times delay between pumps start and stop.

Used By Modules

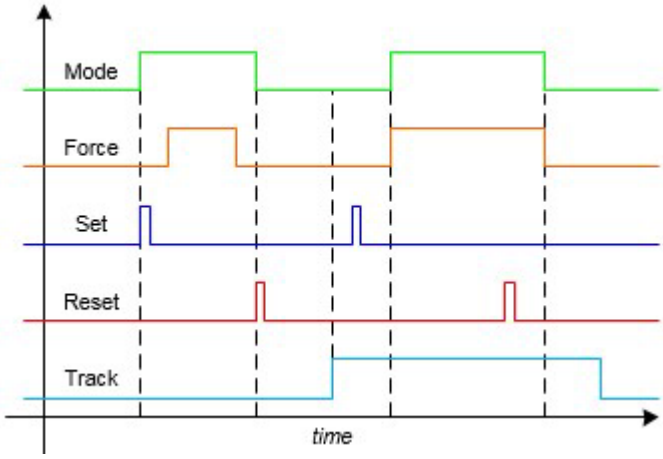
None

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AW_MODE_CONTROL: Manage Operating Mode

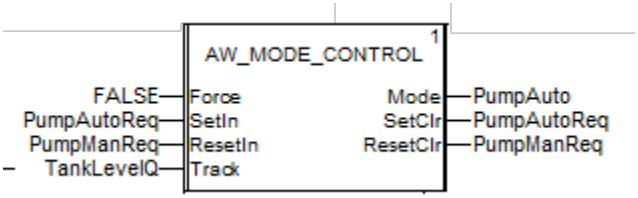
Function Description

This block manages the current state of the Operating Mode. It uses momentary requests to either Set or Reset the Operating Mode.



The *Track* input is used to force the operating mode to the *Force* state when it is set. It maintains the Forced state until the *Track* input is removed. Once removed, it requires the operating mode to be set to the desired state. It does not return to the mode it was in when the *Track* was activated.

Representation



Parameter Description

Input Parameter	Type	Meaning
Force	EBOOL	Force Value to use when Tracking.
SetIn	EBOOL	Issue Mode Set Request (1=Set).
ResetIn	EBOOL	Issue Mode Reset Request (1=Reset).
Track	EBOOL	Cause Mode to follow Force input when set (1=Track).

Output Parameter	Type	Meaning
Mode	EBOOL	Current Operating Mode.
SetClr	EBOOL	Used to clear Set Request.

Output Parameter	Type	Meaning
ResetClr	EBOOL	Used to clear Reset Request.

Embedded Modules

None

Used By Modules

None

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AW_MODGATE: Control Operation of a Hydraulic Gate

Function Description

Controls the operation of a hydraulic gate using a position request and discrete open and close commands. The module adjusts the gate open and close outputs to reach the position specified. The *StopReq* can be used to stop the gate prematurely before the position is reached. Once stopped, the request must be cleared before control can resume.

All commands are checked for proper operation. The following alarms are generated by the module:

Travel Alarm (*TvlAlm*) – This alarm monitors how long a valve should take to reach its setpoint. A timer is associated with this alarm to determine when the alarm is set. The timer starts whenever the valve begins moving. A countdown timer is provided to allow someone to know when the alarm will be set (*TimeRem*).

Uncommand Alarm (*UncmdAlm*) - This alarm is set when the valve has reached setpoint and the valve moved without being commanded.

Module faults are maintained until a successful gate move is completed or a reset is received.

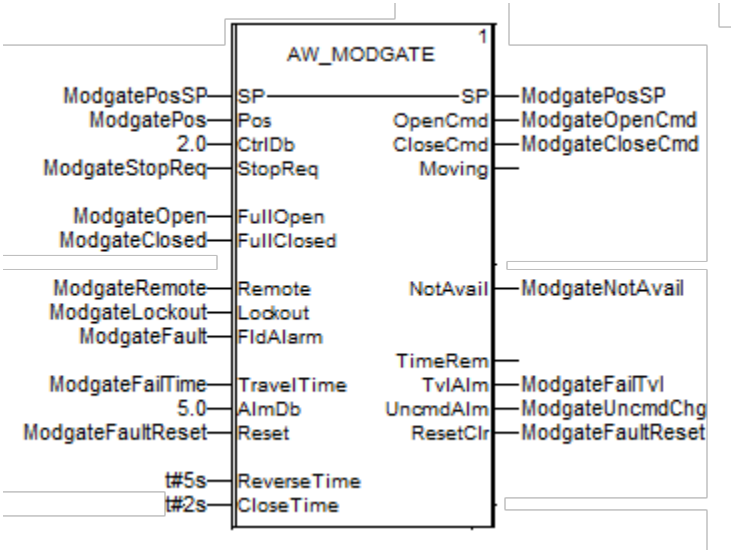
Lockout (*Lockout*) is used to implement a Hold Tag on the device. When the lockout is active, all control by the module is inhibited. This causes the device to be maintained in the state it was in when the tag was applied. Control is not possible until the lockout is removed.

A field alarm (*FldAlarm*) represents a situation external to the PLC that directly affects the operation of the device, such as a hard-wired signal that causes the equipment to stop moving. When the alarm is active, control by the PLC is not possible, therefore the module enters a tracking mode, and it inhibits all control by the module. All momentary control outputs are cleared, and the maintained output tracks the status of the device in order to provide a bumpless transfer when the field alarm is cleared. In addition, it suppresses all command faults that the module can generate. This prevents multiple alarms being generated due to the field alarm.

If the gate is not in *Remote* mode, all control actions and alarming are disabled. The maintained output tracks the status of the device in order to provide a bumpless transfer when the mode is changed.

Two statuses are provided for the gate: *Moving* and *NotAvail*. The *Moving* indication is set whenever an open or close command is in progress. The *NotAvail* status indicates whether the gate is available for control. It is set if a fault exists with the gate, a control *Lockout* is present, or the gate is not in *Remote* mode. A control lockout holds the gate at its current position and inhibits all control actions.

Representation



Parameter Description

Input Parameter	Type	Meaning
Pos	REAL	Current gate position.
CtrlDb	REAL	Variation allowed between SP and Gate Position (i.e Control Deadband) (Default=0.05).
StopReq	EBOOL	Gate Stop Request (1=Stop).
FullOpen	EBOOL	Gate Full Open Indication (1 = Open).
FullClosed	EBOOL	Gate Full Closed Indication (1 = Closed).
Remote	EBOOL	Remote Mode (1=Remote,0=Local) (Default = Remote)
Lockout	EBOOL	Lockout/Tagout (0 = No lockout tag, 1 = Hold)
FldAlarm	EBOOL	Gate Field Alarm, if present (1 = Alarm) (Default = Normal)
TravelTime	TIME	Time allowed to travel from full closed to full open (Default = 10 min).
AlmDb	REAL	Alarm dead-band used to monitor Uncommanded Moves.
Reset	EBOOL	Reset module faults (1 = Reset).
ReverseTime	TIME	Minimum time to pause when changing directions (Default = 5 sec).
CloseTime	TIME	Extra time to maintain close command when full close is reached (Default = 2 sec).

Parameter	Type	Meaning
SP	REAL	Desired gate position.

Output Parameter	Type	Meaning
OpenCmd	EBOOL	Gate Open command (1 = Open).
CloseCmd	EBOOL	Gate Close command (1 = Close).
Moving	EBOOL	Gate moving indication (1 = Moving).
NotAvail	EBOOL	Gate Not Available for control (1 = Not Available).
TimeRem	UINT	Time remaining until travel alarm is generated (Sec).
TvlAlm	EBOOL	Set if Position not within *AlmDb* in time specified (1 = Alarm).
UncmdAlm	EBOOL	Set it gate moved unexpectedly (1 = Alarm).
ResetClr	EBOOL	Used to clear Fault Reset Request.

Embedded Modules

AW_TIME_REM – Calculates time remaining until control fault.

AW_TON_P – Maintains time gate is moving.

COMP_DB – Checks if gate needs to move or has reached specified position.

R_TRIG – Detects when move is complete.

TOF – Times extra close time.

TON – Times delay when reversing directions.

Used By Modules None

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AW_MODVLV: Control Operation of a Modulating Valve

Function Description

This module controls the position of a modulating valve using a position request and an analog output (*PosCmd*). The block compares the set point (*SP*) and the current Valve Position (*Pos*) to determine when to move the Valve. If the position is outside the set point and its dead-band (*CtrlDb*), then the block will adjust the analog output to move the valve to the setpoint specified. The setpoint can change at any time the valve is moving and the output command will respond accordingly.

The block provides two different kinds of faults. These faults will only alarm and not stop the operation of the valve. Any alarms that need to stop the gate from moving needs to use the *FldAlarm* input. When the *FldAlarm* input is set, the valve will stop moving by tracking the current position to the setpoint. To clear any alarm, a new setpoint must be entered. To move the valve the *FldAlarm* input needs to be cleared. The following alarms are generated by the module:

Travel Alarm (*TvlAlm*) – This alarm monitors how long a valve should take to reach its setpoint. A timer is associated with this alarm to determine when the alarm is set. The timer starts whenever the valve begins moving. A countdown timer is provided to allow someone to know when the alarm will be set (*TimeRem*).

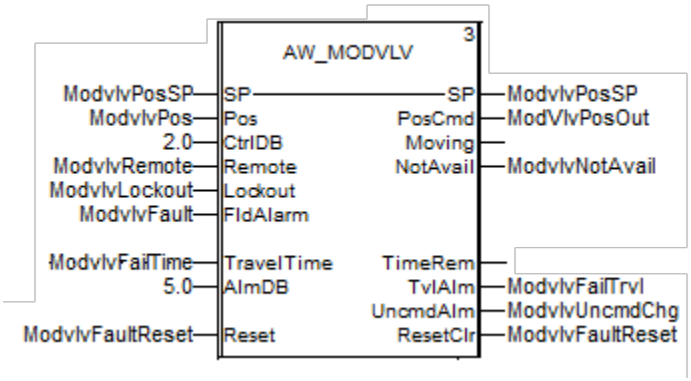
Uncommand Alarm (*UncmdAlm*) - This alarm is set when the valve has reached setpoint and the valve moved without being commanded.

Lockout (*Lockout*) is used to implement a Hold Tag on the device. When the lockout is active, all control by the module is inhibited. This causes the device to be maintained in the state it was in when the tag was applied. Control is not possible until the lockout is removed.

A field alarm (*FldAlarm*) represents a situation external to the PLC that directly affects the operation of the device, such as a hard-wired signal that causes the equipment to stop moving. When the alarm is active, control by the PLC is not possible, therefore the module enters a tracking mode, and it inhibits all control by the module. All momentary control outputs are cleared, and the maintained output tracks the status of the device in order to provide a bumpless transfer when the field alarm is cleared. In addition, it suppresses all command faults that the module can generate. This prevents multiple alarms being generated due to the field alarm.

The Valve Moving (*Moving*) and Valve Not Available (*NotAvail*) statuses are provided by the module. The valve not available output is a summary point indicating that the gate is not be available for remote control. It is set if a fault exists with the valve, a control Lockout is present, or the valve is not in remote mode. A control lockout holds the valve at its current position and inhibits all control actions.

Representation



Parameter Description

Input Parameter	Type	Meaning
Pos	REAL	Current gate position.
CtrlDb	REAL	Variation allowed between SP and Valve Position (i.e Control Dead-band) (Default = 0.05).
Remote	EBOOL	Remote Mode (1 = Remote, 0 = Local) (Default = Remote)
Lockout	EBOOL	Lockout/Tagout (0 = No lockout tag, 1 = Hold)
FldAlarm	EBOOL	Gate Field Alarm, if present (1 = Alarm) (Default = Normal)
TravelTime	TIME	Time allowed to travel from full closed to full open (Default = 10 min).
AlmDb	REAL	Alarm dead-band used to monitor Uncommanded Moves.
Reset	EBOOL	Reset module faults (1 = Reset).

Parameter	Type	Meaning
SP	REAL	Desired valve position.

Output Parameter	Type	Meaning
PosCmd	REAL	Position command output.
Moving	EBOOL	Gate moving indication (1 = Moving).
NotAvail	EBOOL	Gate Not Available for control (1 = Not Available).

Output Parameter	Type	Meaning
TimeRem	UINT	Time remaining until travel alarm is generated (Sec).
TvlAlm	EBOOL	Set if Position not within *AlmDb* in time specified (1 = Alarm).
UncmdAlm	EBOOL	Set it gate moved unexpectedly (1 = Alarm).
ResetClr	EBOOL	Used to clear Fault Reset Request.

Embedded Modules

AW_TIME_REM – Calculates time remaining until fault.

COMP_DB – Checks if move is needed, or position is near the setpoint.

TON – Times how long the valve has been moving.

Used By Modules None.

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AW_MOTOR: Control Operation of a Constant Speed Motor

Function Description

Starts/Stops a two-state device, such as a constant speed pump (running/stopped). Requests are provided for each start and stop commands. Separate command outputs are provided for each request. Both momentary and maintained outputs are available. Momentary outputs are reset when the desired state is reached, or the *FailTime* expires.

The operation of the device is monitored. Errors starting (*StartAlm*) or stopping (*StopAlm*) the device are alarmed. If the device changes state when not expected is also alarmed (*UncmdAlm*).

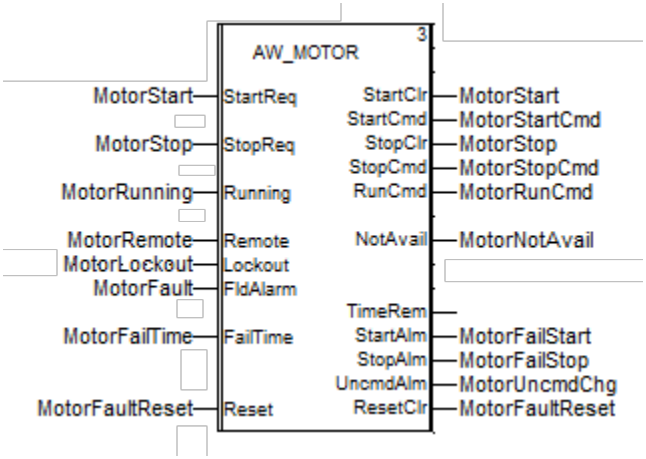
The time remaining (*TimeRem*) output is only active when a command is pending. It counts down from the initial value until it reaches zero. If the value reaches zero, then the associated command alarm is set. The alarm clears any of the momentary control outputs. Once the command completes, the value represents the fault time to reach the other state. For example, if the device is stopped, then the value would represent the time to reach the running state. The command alarm is maintained until reset by the operator, or a request completes successfully.

Lockout (*Lockout*) is used to implement a Hold Tag on the device. When the lockout is active, all control by the module is inhibited. This causes the device to be maintained in the state it was in when the tag was applied. Control is not possible until the lockout is removed.

A field alarm (*FldAlarm*) represents a situation external to the PLC that directly affects the operation of the device, such as a hard-wired signal that causes the equipment to stop running. When the alarm is active, control by the PLC is not possible, therefore the module enters a tracking mode, and it inhibits all control by the module. All momentary control outputs are cleared, and the maintained output tracks the status of the device in order to provide a bumpless transfer when the field alarm is cleared. In addition, it suppresses all command faults that the module can generate. This prevents multiple alarms being generated due to the field alarm.

When the device is not operating in Remote mode, no commands are generated. The status of the device is monitored, and the outputs are adjusted to avoid a disturbance in the operation when the mode is changed.

Representation



Parameter Description

Description of the parameters:

Input Parameter	Type	Meaning
StartReq	EBOOL	Requests the device to start (1 = Start).
StopReq	EBOOL	Requests the device to stop (1 = Stop).
Running	EBOOL	Feedback indicating device is running (1 = Running).
Remote	EBOOL	Remote Mode (1=Remote,0=Local) (Default = Remote)
Lockout	EBOOL	Lockout/Tagout (0 = No lockout tag, 1 = Hold)
FldAlarm	EBOOL	Device Field Alarm, if present (1 = Alarm) (Default = Normal)
FailTime	TIME	Time allowed to start or stop the device (Default = 5 sec).
Reset	EBOOL	Reset module faults (1 = Reset).

Output Parameter	Type	Meaning
StartClr	EBOOL	Used to clear start request. Typically assigned to *StartReq* parameter. Request is cleared once device starts or fault occurs.
StartCmd	EBOOL	Start device momentary output (1 = Start).
StopClr	EBOOL	Used to clear stop request. Typically assigned to *StopReq* parameter. Request is cleared once device stops or fault occurs.
StopDmd	EBOOL	Stop device momentary output (1 = Stop).
RunCmd	EBOOL	Maintained run output (1 = Run).
NotAvail	EBOOL	Device Not Available for control (1 = Not Available).
TimeRem	UINT	Time remaining until start or stop command alarm is generated (Sec).
StartAlm	EBOOL	Indicates if device failed to start in the amount of time specified. (1 = Failed, 0 = Normal)

Output Parameter	Type	Meaning
StopAlm	EBOOL	Indicates if device failed to stop in the amount of time specified (1 = Failed, 0 = Normal)
UncmdAlm	EBOOL	Indicates if device started or stopped without being command. (1 = Failed, 0 = Normal)
ResetClr	EBOOL	Used to clear Fault Reset Request.

Embedded Modules

AW_TIME_REM – Calculates time remaining until fault.

TON – Times how long the motor has been starting or stopping.

Used By Modules None.

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AW_RT_STARTS: Accumulate Equipment Runtime and Starts

Function Description

Monitors running input and accumulates runtime in 0.1 hours and number of times the equipment has started today, yesterday, current month, previous month, and lifetime accumulation.

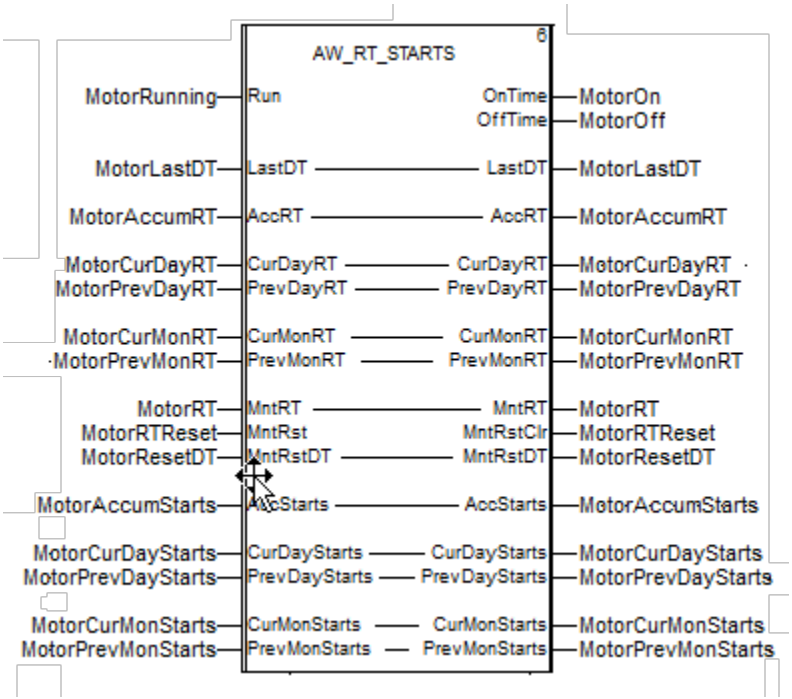
A resettable maintenance runtime is maintained as well. It provides the accumulated value before the reset signal is set for monitoring current and previous values. Provides the date and time the value was reset.

In addition, the module provides how long the equipment has been running and how long it has been stopped.

The module is configured such that its current and previous values may be manually entered after download or sync with an external meter.

The module is provided with a *ResetClr* output that can be used to clear the *Reset* request after the reset has been performed, if desired.

Representation



Parameter Description

Description of the input parameters:

Input Parameter	Type	Meaning
Run	EBOOL	Run indication to monitor. (1=Running)
MntRst	EBOOL	Resets maintenance runtime. (1=Reset)

Output Parameter	Type	Meaning
LastDT	DATE_TIME	Date and time when the equipment was last run.
AccRT	REAL	Lifetime accumulated runtime in 0.1-hour increments.
CurDayRT	REAL	Current day accumulated runtime in 0.1-hour increments.
PrevDayRT	REAL	Previous day accumulated runtime in 0.1-hour increments.
CurMonRT	REAL	Current month accumulated runtime in 0.1-hour increments.
PrevMonRT	REAL	Previous month accumulated runtime in 0.1-hour increments.
MntRT	REAL	Current resettable maintenance runtime in 0.1-hour increments.
MntRstDT	DATE_TIME	Date and time the maintenance runtime was reset.
AccStarts	REAL	Lifetime accumulated number of starts.
CurDayStarts	REAL	Current Day accumulated number of starts.
PrevDayStarts	REAL	Previous Day accumulated number of starts.
CurMonStarts	REAL	Current Month accumulated number of starts.
PrevMonStarts	REAL	Previous Month accumulated number of starts.

Parameter	Type	Meaning
ResetClr	EBOOL	Used to clear Reset request after clearing accumulated values. Typically assigned to Reset parameter. Reset is cleared once it is processed by module

DATE_TIME Description

Data structure parameters:

Element	Data Type	Meaning
Year	UINT	Year (2000 – 2099).
Month	UINT	Month (1 – 12).
Day	UINT	Day (1 – 31).
Hour	UINT	Hour (0 – 23).
Minute	UINT	Minute (0 – 59).
Second	UINT	Second (0 – 59).

Embedded Modules

AW_GET_TOD – Captures *LastDT* and *ResetDT* date and time.

AW_TON_P – Accumulated runtime in 6-minute increments.

R_TRIG – Detects *Run*, *Reset* and 6-minute accumulation.

Used By Modules None.

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AW_RUNTIME: Accumulate Equipment Runtime and Starts

Function Description

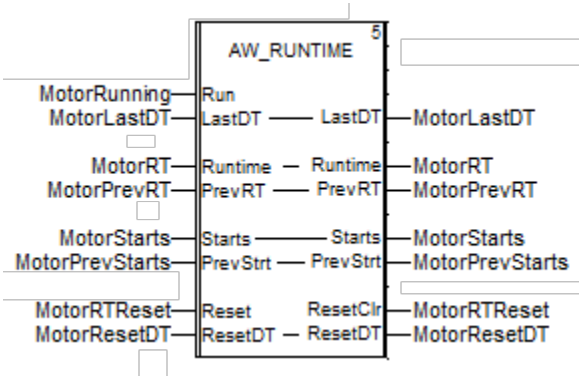
Monitors running input and accumulates runtime in 0.1 hours and number of times the equipment has started.

Provides accumulated values before the reset signal for monitoring current and previous values. Provides the date and time the values were reset.

The module is configured such that its current and previous values may be manually entered after download or sync with an external meter.

The module is provided with a *ResetClr* output that can be used to clear the *Reset* request after the reset has been performed, if desired.

Representation



Parameter Description

Input Parameter	Type	Meaning
Run	EBOOL	Run indication to monitor. (1=Running)
Reset	EBOOL	Resets current runtime and starts. Current values are transferred to previous values before reset. (1=Reset)

Parameter	Type	Meaning
LastDT	DATE_TIME	Date and time when the equipment was last run.
Runtime	REAL	Current accumulated runtime in 0.1-hour increments.
PrevRT	REAL	Previous accumulated runtime in 0.1-hour increments.
Starts	REAL	Current accumulated number of starts.
PrevStarts	REAL	Previous accumulated number of starts.
ResetDT	DATE_TIME	Date and time the runtime/starts were reset.

Output Parameter	Type	Meaning
ResetClr	EBOOL	Used to clear Reset request after clearing accumulated values. Typically assigned to Reset parameter. Reset is cleared once it is processed by module

DATE_TIME Description

Data structure parameters:

Element	Data Type	Meaning
Year	UINT	Year (2000 – 2099).
Month	UINT	Month (1 – 12).
Day	UINT	Day (1 – 31).
Hour	UINT	Hour (0 – 23).
Minute	UINT	Minute (0 – 59).
Second	UINT	Second (0 – 59).

Embedded Modules

AW_GET_TOD – Captures *LastDT* and *ResetDT* date and time.

AW_TON_P – Accumulated runtime in 6-minute increments.

R_TRIG – Detects *Run*, *Reset* and 6-minute accumulation.

Used By Modules None.

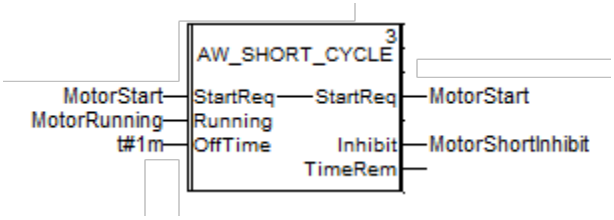
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AW_SHORT_CYCLE: Inhibit Equipment Restart

Function Description

Some equipment needs to be limited in how often they can be started. One method employed is to avoid 'short cycling'. 'Short-cycling' is the restarting the equipment soon after it is stopped. This module detects when the equipment stops, and them issues an inhibit signal for the period specified, *OffTime*.

Representation



Parameter Description

Input Parameter	Type	Meaning
Running	EBOOL	Running indication of the equipment (1=Running)
OffTime	TIME	The period of time to inhibit the restart when the equipment stops (Default = 5 minutes)

Output Parameter	Type	Meaning
Inhibit	EBOOL	Set when the equipment stops for the time specified.
TimeRem	UINT	The number of seconds before another start is allowed.

Parameter	Type	Meaning
StartReq	EBOOL	Used to clear the start request while the Inhibit state is active.

Embedded Modules

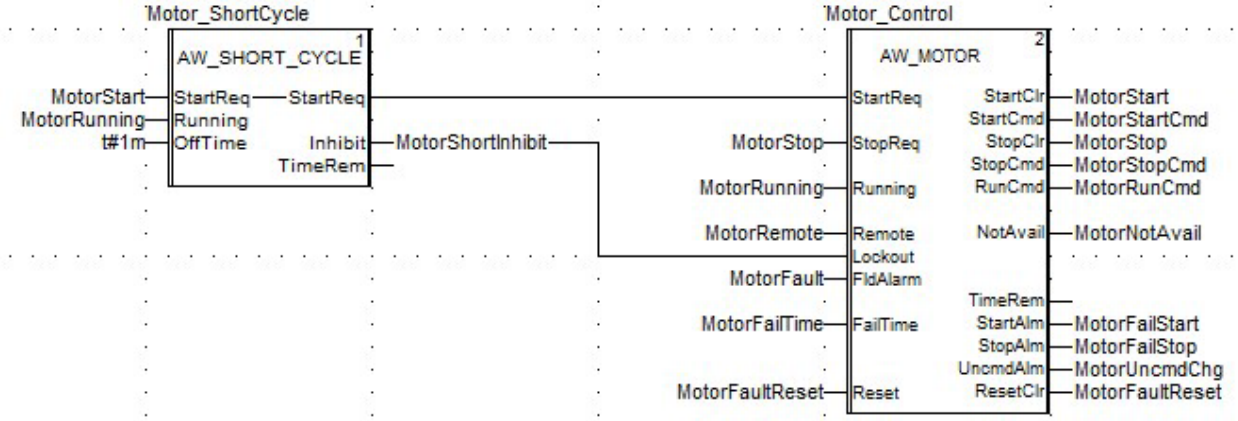
AW_TIME_REM – Calculates time remaining until fault.

COMP_DB – Checks if move is needed, or position is near the setpoint.

TON – Times how long the valve has been moving.

Used By Modules None.

Sample Code



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AW_TRANSITIONS: Accumulate Valve Open Time and Transitions

Function Description

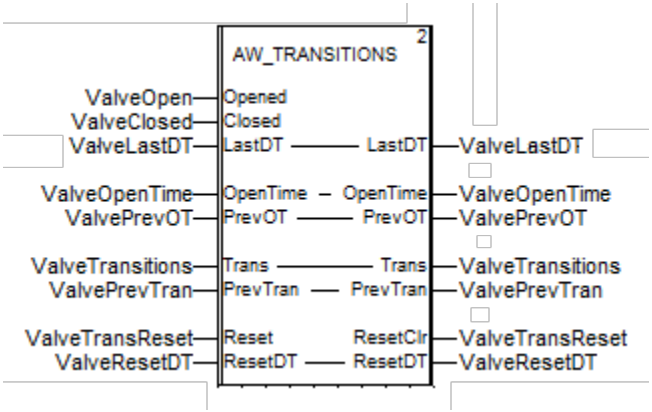
Monitors open and close states of a valve. Once the valve is open it accumulates the open time in 0.1 hours. It accumulates each time the valve transitions from open to close or close to open.

Provides accumulated values before the reset signal for monitoring current and previous values. Provides the date and time the values were reset.

The module is configured such that its current and previous values may be manually entered after download or sync with an external meter.

The module is provided with a *ResetClr* output that can be used to clear the *Reset* request after the reset has been performed, if desired.

Representation



Parameter Description

Input Parameter	Type	Meaning
Open	EBOOL	Set when the Valve is open (1 = Open)
Closed	EBOOL	Set when the Valve is closed (1 = Closed)
Reset	EBOOL	Resets current open time and transitions. Current values are transferred to previous values before reset. (1=Reset)

Parameter	Type	Meaning
LastDT	DATE_TIME	Date and time when the valve was last opened.
OpenTime	REAL	Current accumulated open time in 0.1-hour increments.
PrevOT	REAL	Previous accumulated open time in 0.1-hour increments.
Trans	REAL	Current accumulated number of transitions.

Parameter	Type	Meaning
PrevTran	REAL	Previous accumulated number of transitions.
ResetDT	DATE_TIME	Date and time the open time/transitions were reset.

Output Parameter	Type	Meaning
ResetClr	EBOOL	Used to clear Reset request after clearing accumulated values. Used to clear reset signal. Typically assigned to Reset parameter. Reset is cleared once it is processed by module

DATE_TIME Description

Data structure parameters:

Element	Data Type	Meaning
Year	UINT	Year (2000 – 2099).
Month	UINT	Month (1 – 12).
Day	UINT	Day (1 – 31).
Hour	UINT	Hour (0 – 23).
Minute	UINT	Minute (0 – 59).
Second	UINT	Second (0 – 59).

Embedded Modules

AW_GET_TOD – Captures *LastDT* and *ResetDT* date and time.

AW_TON_P – Accumulated open time in 6-minute increments.

R_TRIG – Detects *Run*, *Reset* and 6-minute accumulation.

Used By Modules None.

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AW_VALVE: Control Operation of a Two-State Valve

Function Description

Opens/Closes a two-state valve. Requests are provided for each open and close command. Separate command outputs are provided for each request. Both momentary and maintained outputs are available. Momentary outputs are reset when the desired state is reached, or the *FailTime* expires. An optional Stop request is available to abort the transition prematurely, if needed.

The operation of the device is monitored. Errors opening (*OpenAlm*) or closing (*CloseAlm*) the valve are alarmed. If the valve changes state when not expected is also alarmed (*UncmdAlm*).

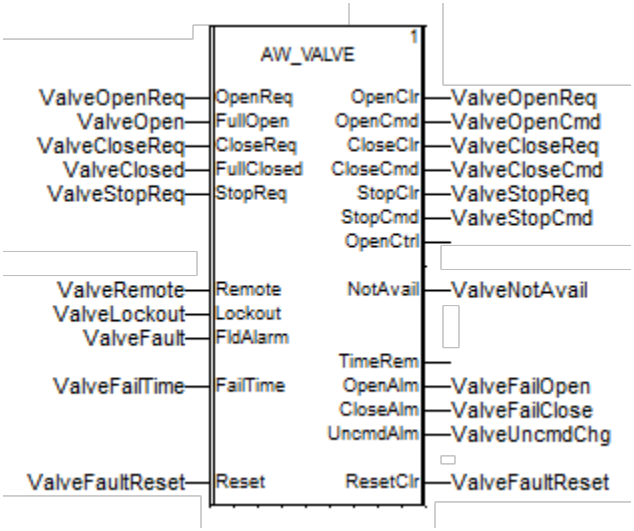
The time remaining (*TimeRem*) output is only active when a command is pending. It counts down from the initial value until it reaches zero. If the value reaches zero, then the associated command alarm is set. The alarm clears any of the momentary control outputs. Once the command completes, the value represents the fault time to reach the other state. For example, if the device is closed, then the value would represent the time to reach the open state. The command alarm is maintained until reset by the operator, or a request completes successfully.

Lockout (*Lockout*) is used to implement a Hold Tag on the device. When the lockout is active, all control by the module is inhibited. This causes the device to be maintained in the state it was in when the tag was applied. Control is not possible until the lockout is removed.

A field alarm (*FldAlarm*) represents a situation external to the PLC that directly affects the operation of the device, such as a hard-wired signal that causes the equipment to stop moving. When the alarm is active, control by the PLC is not possible, therefore the module enters a tracking mode, and it inhibits all control by the module. All momentary control outputs are cleared, and the maintained output tracks the status of the device in order to provide a bumpless transfer when the field alarm is cleared. In addition, it suppresses all command faults that the module can generate. This prevents multiple alarms being generated due to the field alarm.

When the device is not operating in *Remote* mode, no commands are generated. The status of the device is monitored, and the outputs are adjusted to avoid a disturbance in the operation when the mode is changed.

Representation



Parameter Description

Input Parameter	Type	Meaning
OpenReq	EBOOL	Requests the valve to open (1=Open).
FullOpen	EBOOL	Feedback indicating valve is open (1=Open).
CloseReq	EBOOL	Requests the valve to close (1=Close).
FullClosed	EBOOL	Feedback indicating valve is closed (1=Closed).
StopReq	EBOOL	Request the valve to stop at its current location (1=Stop)
Remote	EBOOL	Remote Mode (1=Remote,0=Local) (Default = Remote)
Lockout	EBOOL	Lockout/Tagout (0 = No lockout tag, 1 = Hold)
FldAlarm	EBOOL	Device Field Alarm, if present (1 = Alarm) (Default = Normal)
FailTime	TIME	Time allowed to start or stop the device (Default = 5 sec).
Reset	EBOOL	Reset module faults (1 = Reset).

Output Parameter	Type	Meaning
OpenClr	EBOOL	Used to clear open request. Typically assigned to *OpenReq* parameter. Request is cleared once valve opens or fault occurs.
OpenCmd	EBOOL	Open Valve momentary output (1=Open).
CloseClr	EBOOL	Used to clear close request. Typically assigned to *CloseReq* parameter. Request is cleared once valve closes or fault occurs.
CloseCmd	EBOOL	Close valve momentary output (1=Close).
StopClr	EBOOL	Used to clear the stop request. Typically assigned to the *StopReq* parameter. Request is cleared once command outputs have been reset.
StopCmd	EBOOL	Set when Stop request has been received. Output is maintained until an Open or Close request is received.

Output Parameter	Type	Meaning
OpenCtrl	EBOOL	Maintained open output (1=Open).
NotAvail	EBOOL	Device Not Available for control (1 = Not Available).
TimeRem	UINT	Time remaining until start or stop command alarm is generated (Sec).
OpenAlm	EBOOL	Indicates if valve failed to open in the amount of time specified. (1=Fault)
CloseAlm	EBOOL	Indicates if valve failed to close in the amount of time specified (1=Fault)
UncmdAlm	EBOOL	Indicates if device started or stopped without being command. (1=Failed, 0=Normal)
ResetClr	EBOOL	Used to clear Fault Reset Request.

Embedded Modules

AW_TIME_REM – Calculates time remaining until fault.

TON – Times how long the valve has been opening or closing.

Used By Modules None.

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AW_VFD: Control Operation of a Variable Frequency Drive

Function Description

Controls the operation of a variable frequency Drive (VFD) using discrete start/stop and speed requests. Both momentary and maintained outputs are available. Momentary outputs are reset when the desired state is reached, or the *FailTime* expires. The speed request is clamped between the minimum and maximum speeds specified.

All commands are checked for proper operation. The following alarms are generated by the module:

Start Alarm (*StartAlm*) – This alarm is set if the drive fails to start before the *FailTime* expires.

Stop Alarm (*StopAlm*) – This alarm is set if the drive fails to stop before the *FailTime* expires.

Adjust Alarm (*AdjustAlm*) – This alarm monitors how long a drive should take to reach its setpoint. A timer (*AdjustTime*) is associated with this alarm to determine when the alarm is set. The timer starts whenever the speed setpoint is changed. A countdown timer is provided to allow someone to know when the alarm will be set (*TimeRem*).

Uncommand Alarm (*UncmdAlm*) - This alarm is set when the drive has reached the setpoint and the drive changed speed or stopped or started moved without being commanded.

Module faults are maintained until a successful speed change is completed or a reset is received.

Lockout (*Lockout*) is used to implement a Hold Tag on the device. When the lockout is active, all control by the module is inhibited. This causes the device to be maintained in the state it was in when the tag was applied. Control is not possible until the lockout is removed.

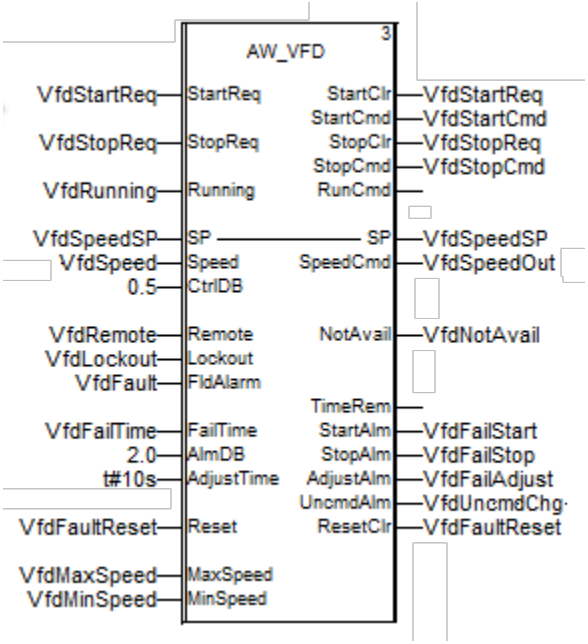
A field alarm (*FldAlarm*) represents a situation external to the PLC that directly affects the operation of the device, such as a hard-wired signal that causes the equipment to stop running. When the alarm is active, control by the PLC is not possible, therefore the module enters a tracking mode, and it inhibits all control by the module. All momentary control outputs are cleared, and the maintained output tracks the status of the device in order to provide a bumpless transfer when the field

alarm is cleared. In addition, it suppresses all command faults that the module can generate. This prevents multiple alarms being generated due to the field alarm.

If the drive is not in *Remote* mode, all control actions are disabled, and all alarming is disabled.

The *NotAvail* status indicates whether the drive is available for control. It is set if a fault exists with the drive, a control *Lockout* is present, or the drive is not in *Remote* mode. A control lockout holds the drive at its current speed and inhibits all control actions.

Representation



Parameter Description

Input Parameter	Type	Meaning
StartReq	EBOOL	Requests the device to start (1=Start).
StopReq	EBOOL	Requests the device to stop (1=Stop).
Running	EBOOL	Feedback indicating device is running (1=Running).
Speed	REAL	Current device speed.
CtrlDb	REAL	Variation allowed between SP and Drive Speed (i.e Control Deadband) (Default=1.0).
Remote	EBOOL	Remote Mode (1=Remote, 0=Local) (Default=Remote)
Lockout	EBOOL	Lockout/Tagout (0=No lockout tag, 1=Hold)
FldAlarm	EBOOL	Drive Field Alarm, if present (1=Alarm) (Default=Normal)
FailTime	TIME	Time allowed to start/stop the drive (Default=5 sec).

Input Parameter	Type	Meaning
AlmDb	REAL	Alarm dead-band used to monitor Uncommanded Moves.
AdjustTime	TIME	Time allowed to go from minimum to maximum speed (default=10 sec)
Reset	EBOOL	Reset module faults (1=Reset).
MaxSpeed	REAL	Maximum speed allowed to be output (default=100.0).
MinSpeed	REAL	Minimum speed allowed to be output (default=40.0).

Parameter	Type	Meaning
SP	REAL	Desired drive speed.

Output Parameter	Type	Meaning
StartClr	EBOOL	Used to clear start request. Typically assigned to *StartReq* parameter. Request is cleared once device starts or fault occurs.
StartCmd	EBOOL	Start device momentary output (1=Start).
StopClr	EBOOL	Used to clear stop request. Typically assigned to *StopReq* parameter. Request is cleared once device stops or fault occurs.
StopDmd	EBOOL	Stop device momentary output (1=Stop).
RunCmd	EBOOL	Maintained run output (1=Run).
SpeedCmd	REAL	Speed Command Output.
NotAvail	EBOOL	Drive Not Available for control (1=Not Available).
TimeRem	UINT	Time remaining until start/stop or adjust alarm is generated (Sec).
StartAlm	EBOOL	Indicates if device failed to start in the amount of time specified. (1=Failed, 0=Normal)
StopAlm	EBOOL	Indicates if device failed to stop in the amount of time specified (1=Failed, 0=Normal)
AdjustAlm	EBOOL	Set if Speed not within *AlmDb* in time specified (1=Alarm).
UncmdAlm	EBOOL	Set it drive started/stopped or changed speed unexpectedly (1=Alarm).
ResetClr	EBOOL	Used to clear Fault Reset Request.

Embedded Modules

AW_TIME_REM – Calculates time remaining until fault.

COMP_DB – Checks if adjustment is needed, or speed is near the setpoint

TON – Times how long the VFD has been starting or stopping or adjusting speed.

Used By Modules None.

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AW_READ_MBTCP: Read Data from Modbus-TCP Slave Device

Function Description

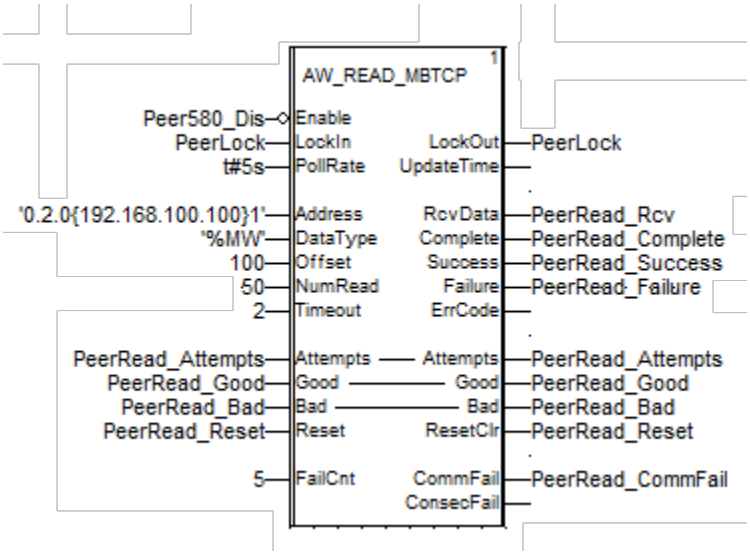
This block requests the specified data from a slave device using the Modbus TCP/IP protocol. It uses the Unity READ_VAR block to perform the read request. See the documentation on the READ_VAR block for additional information on how the request is made.

The lock is used by multiple read or write requests to limit the number of simultaneous requests. Only the module holding the lock can issue the request.

In addition to formatting the read request, and checking if it completes successfully, it maintains statistics to assist in the management of the communication link.

A *CommFail* alarm is generated if a valid message is not completed within the time specified.

Representation



Parameter Description

Input Parameter	Type	Meaning
Enable	BOOL	Set to enable polling of the remote device (1 = Enabled) (default = Enabled)
LockIn	BOOL	Poll synchronization Lock (1 = Active)
PollRate	TIME	How often to poll the data (default = 1 sec)

Input Parameter	Type	Meaning
Address	STRING	TCP Address of the Slave device. Referencing the example above: '0.2.0' represents CPU Rack 0 Slot 2 and Channel 0 for a M580 NOC module. {192.168.100.100} is the IP address of the remote device. The 1 is the Modbus address of the device. The default Modbus addresses for other PLCs and PQMs is typically 1, whereas a 469 has a default Modbus address of 253.
DataType	STRING	Data type of the data to be read. Possible values are '%M' for Boolean data, and '%MW' for analog data.
Offset	DINT	Index of the first object to read.
NumRead	INT	Number of objects to read.
TimeOut	INT	Number of seconds for poll to respond (default = 1 sec).
Reset	BOOL	Resets accumulated communication statistics.
FailCnt	UINT	Number of consecutive failed messages before generating an alarm. (default = 5)

Output Parameter	Type	Meaning
LockOut	BOOL	Poll synchronization Lock (1 = Active).
UpdateTime	TIME	Time since last good message.
RcvData	ANY_ARRAY_INT	Received object data.
Complete	BOOL	Set when Read request completes, either successfully or not.
Success	BOOL	Set when Read request completes successfully.
Failure	BOOL	Set when Read request failed to complete successfully.
ErrCode	INT	Error code of last failed request. See READ_VAR for more information.
ResetClr	BOOL	Used to clear communication reset request.
CommFail	BOOL	Set when successful poll has not occurred within number specified (1=Fail)
ConsecCnt	UINT	Current number of consecutive failed messages

Parameter	Type	Meaning
Attempts	UDINT	Number of communication attempts.
Good	UDINT	Number of Good messages.
Bad	UDINT	Number of Bad messages.

Embedded Modules

ADDM – Converts *Address* into format used by READ_VAR.

AW_MUTEX – Obtains exclusive access to network link.

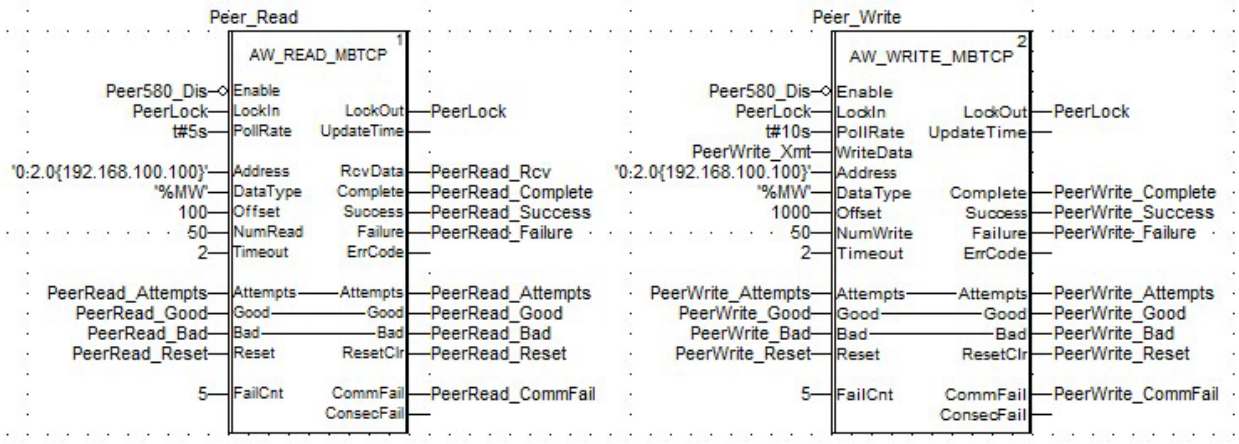
CTU_UINT – Counts number of consecutive failed messages.

READ_VAR – Reads data from slave device.

TON – Times how long between polls and since last successful message.

Used By Modules None.

Sample Code



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AW_WRITE_MBTCP: Write Data to Modbus-TCP Slave Device

Function Description

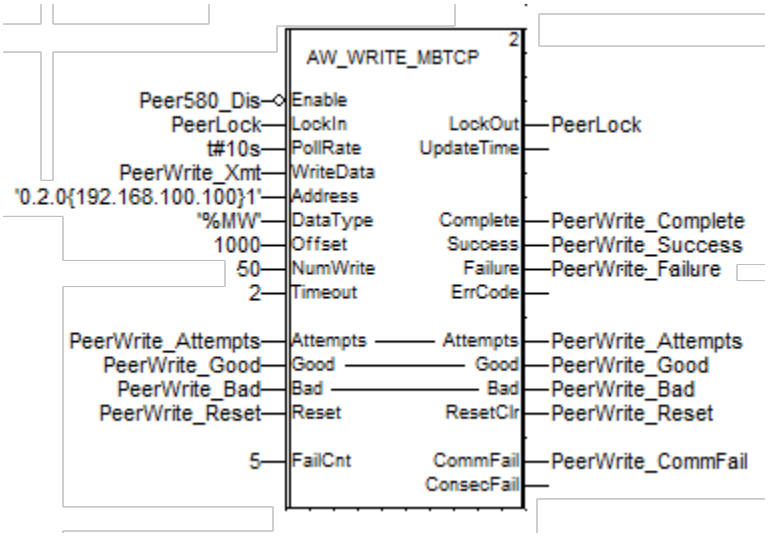
This block writes the specified data to a slave device using the Modbus TCP/IP protocol. It uses the Unity WRITE_VAR block to perform the write request. See the documentation on the WRITE_VAR block for additional information on how the request is made.

The lock is used by multiple read or write requests to limit the number of simultaneous requests. Only the module holding the lock can issue the request.

In addition to formatting the write request, and checking if it completes successfully, it maintains statistics to assist in the management of the communication link.

An *CommFail* alarm is generated if a valid message is not completed within the time specified.

Representation



Parameter Description

Input Parameter	Type	Meaning
Enable	BOOL	Set to enable writing to the remote device (1 = Enabled) (default = Enabled)
LockIn	BOOL	Poll synchronization Lock (1 = Active)
PollRate	TIME	How often to write the data (default = 1 sec)
WriteData	ANY_ARRAY_INT	Written object data.

Input Parameter	Type	Meaning
Address	STRING	TCP Address of the Slave device. Referencing the example above: '0.2.0' represents CPU Rack 0 Slot 2 and Channel 0 for a M580 NOC module. {192.168.100.100} is the IP address of the remote device. The 1 is the Modbus address of the device. The default Modbus addresses for other PLCs and PQMs is typically 1, whereas a 469 has a default Modbus address of 253.
DataType	STRING	Data type of the data to be written. Possible values are '%M' for Boolean data, and '%MW' for analog data.
Offset	DINT	Index of the first object to write.
NumRead	INT	Number of objects to write.
TimeOut	INT	Number of seconds for request to respond (default = 1 sec).
Reset	BOOL	Resets accumulated communication statistics.
FailCnt	UINT	Number of consecutive failed messages before generating an alarm. (default = 5)

Output Parameter	Type	Meaning
LockOut	BOOL	Poll synchronization Lock (1 = Active).
UpdateTime	TIME	Time since last good message.
Complete	BOOL	Set when Write request completes, either successfully or not.
Success	BOOL	Set when Write request completes successfully.
Failure	BOOL	Set when Write request failed to complete successfully.
ErrCode	INT	Error code of last failed request. See WRITE_VAR for more information.
ResetClr	BOOL	Used to clear communication reset request.
CommFail	BOOL	Set when successful request has not occurred within number specified (1=Fail)
ConsecCnt	UINT	Current number of consecutive failed messages

Parameter	Type	Meaning
Attempts	UDINT	Number of communication attempts.
Good	UDINT	Number of Good messages.
Bad	UDINT	Number of Bad messages.

Embedded Modules

ADDM – Converts *Address* into format used by WRITE_VAR.

AW_MUTEX – Obtains exclusive access to network link.

CTU_UINT – Counts number of consecutive failed messages.

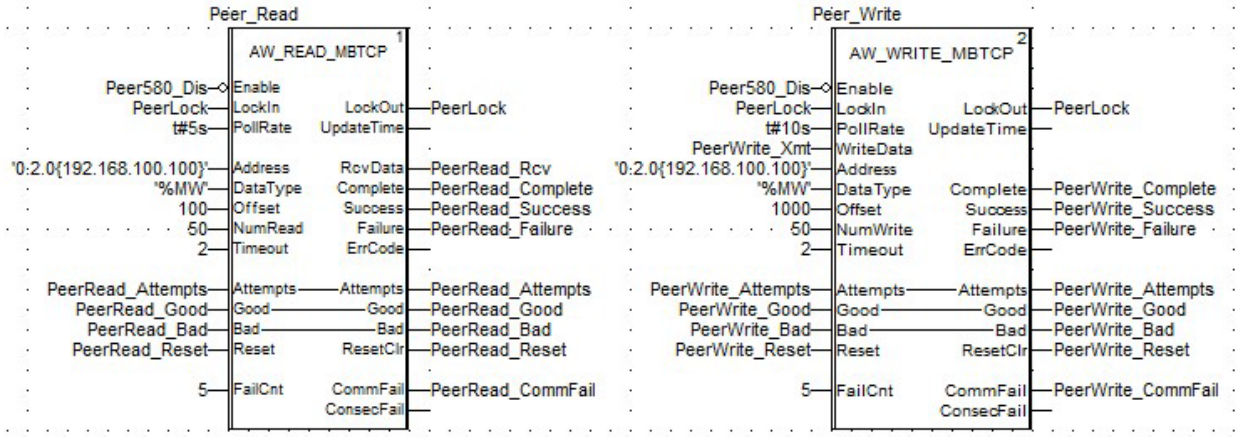
TON – Times how long between polls and since last successful message.

WRITE_VAR – Writes data to slave device.

Used By Modules None.

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Sample Code



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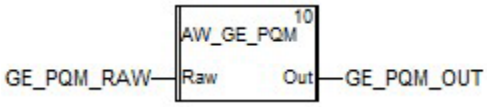
AW_GE_PQM: Extract Data from Multilin PQMII Data Buffer

Function Description

The Multilin PQMII power monitoring device data is read using the AW_READ_MBTCP block. The data extracted from AW_READ_MBTCP is raw in nature and carries many different data formats. The AW_GE_PQM block extracts the raw data from the buffer and formats the variables into an array of REAL and DATE_TIME values for HMI access.

The PQMII has over 1700 parameters available for monitoring and control. It would require multiple polls to access all the data required by the City. By using the User-Definable Memory (UDM) Map of the PQMII all the data can be accessed in one poll. The AW_GE_PQM module relies on the UDM configured as described below. The UDM can be setup manually or written by the PLC using the AW_WRITE_MBTCP with a properly configured array.

Representation



Parameter Description

Description of the input parameters:

Input Parameter	Type	Meaning
Raw	ARRAY[0..124] OF INT	Raw data from the PQMII, 125 is the maximum number of integers that can be defined in the User-definable Memory Map of the PQMII

Output Parameter	Type	Meaning
Out.Ia	REAL	Phase A Current (A)
Out.Ib	REAL	Phase B Current (A)
Out.Ic	REAL	Phase C Current (A)
Out.Iunb	REAL	Current Unbalance (%)
Out.Van	REAL	Voltage Van (V)
Out.Vbn	REAL	Voltage Vbn (V)
Out.Vcn	REAL	Voltage Vcn (V)
Out.Vab	REAL	Voltage Vab (V)
Out.Vbc	REAL	Voltage Vbc (V)

Output Parameter	Type	Meaning
Out.Vca	REAL	Voltage Vca (V)
Out.Vunb	REAL	Voltage Unbalance (%)
Out.KW	REAL	3 Phase Real Power (KW)
Out.KVA	REAL	3 Phase Apparent Power (KVA)
Out.KVAR	REAL	3 Phase Reactive Power (KVAR)
Out.PF	REAL	3 Phase Power Factor
Out.KWhCurDay	REAL	KWh Today (KWh)
Out.KWhPrevDay	REAL	KWh Yesterday (KWh)
Out.KWhCurMon	REAL	KWh Current Month (KWh)
Out.KWhPrevMon	REAL	KWh Previous Month (KWh)
Out.Date_Time	DATE_TIME	Device Current Date and Time

DATE_TIME Description

Data structure parameters:

Element	Data Type	Meaning
Year	UINT	Year (2000 – 2099).
Month	UINT	Month (1 – 12).
Day	UINT	Day (1 – 31).
Hour	UINT	Hour (0 – 23).
Minute	UINT	Minute (0 – 59).
Second	UINT	Second (0 – 59).

User-Definable Memory Array for PQMII

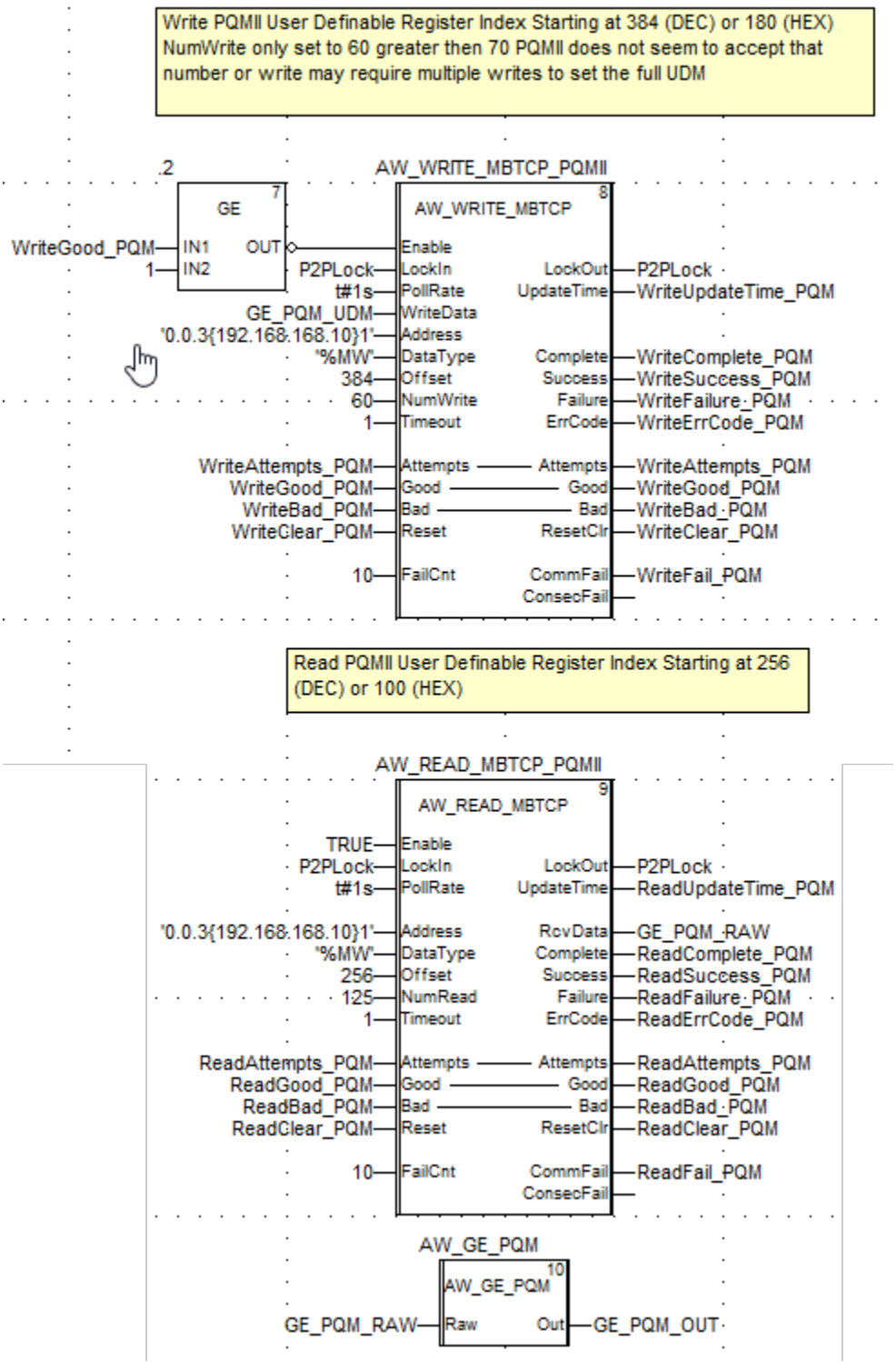
Description of the UDM assignments required for this module to function properly:

User Memory Map Area			PQMII Register Address			
Index	(DEC)	(HEX)	(DEC)	(HEX)	Description	Format
0	384	180	576	240	Phase A Current (A)	F1
1	385	181	577	241	Phase B Current (A)	F1
2	386	182	578	242	Phase C Current (A)	F1
3	387	183	581	245	Current Unbalance (0.1 x %)	F1
4	388	184	640	280	Voltage Van (V)	F3
5	389	185	641	281		

User Memory Map Area			PQMII Register Address			
Index	(DEC)	(HEX)	(DEC)	(HEX)	Description	Format
6	390	186	642	282	Voltage Vbn (V)	F3
7	391	187	643	283		
8	392	188	644	284	Voltage Vcn (V)	F3
9	393	189	645	285		
10	394	18A	648	288	Voltage Vab (V)	F3
11	395	18B	649	289		
12	396	18C	650	28A	Voltage Vbc (V)	F3
13	397	18D	651	28B		
14	398	18E	652	28C	Voltage Vca (V)	F3
15	399	18F	653	28D		
16	400	190	656	290	Voltage Unbalance (0.1 x %)	F1
17	401	191	752	2F0	3-Phase Power (0.01 x KW)	F4
18	402	192	753	2F1		
19	403	193	756	2F4	3-Phase Apparent Power (0.01 x KVA)	F3
20	404	194	757	2F5		
21	405	195	754	2F2	3-Phase Reactive Power (0.01 x KVAR)	F4
22	406	196	755	2F3		
23	407	197	758	2F6	3-Phase Power Factor (0.01 x PF)	F2
24	408	198	562	232	Current Device Date	F24
25	409	199	563	233		F25
26	410	19A	560	230	Current Device Time	F22
27	411	19B	561	231		F23
28	412	19C	976	3D0	3-Phase Real Energy Used (KWh)	F3
29	413	19D	977	3D1		

See PQMII Power Quality Meter Communications Guide, GEK-113532, for additional information on register assignments and associated formats.

Sample Code



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AW_GE_SR469: Extract Data from Multilin SR-469 Data Buffer

Function Description

The Multilin SR-469 protectiion relay device data is read via the AW_READ_MBTCP block. The data extracted from AW_READ_MBTCP is raw in nature and carry many different data formats. The AW_GE_SR469 block extracts the raw data from the GE SR469 and formats the variables into a uniform array of REAL and DATA_TIME values for the HMI to access.

The SR469 has over 4000 parameters available for monitoring and control. It would require multiple polls to access all the data required by the City. By using the User-Definable Memory (UDM) Map of the PQMII all the data can be accessed in one poll. The AW_GE_PQM module relies on the UDM configured as described below. The UDM can be setup manually or written by the PLC using the AW_WRITE_MBTCP with a properly configured array.

For the 869 relay, GE Multilin provides a 469-compatibility mode after EnerVista 8 Series Setup version 2.72 or later (where the Modbus registers will emulate a 469 relay).[i] When the 469compatibility mode is utilized, then extracting and processing the data from the 869 is identical to those of the 469.

Representation



Parameter Description

Input Parameter	Type	Meaning
Raw	ARRAY[0..124] OF INT	Raw data from the 469 device. 125 is the maximum number of integers that can be defined in the User-definable Memory Map of the 469.

Output Parameter	Type	Meaning
Out.Ia	REAL	Phase A Current (A)
Out.Ib	REAL	Phase B Current (A)
Out.Ic	REAL	Phase C Current (A)
Out.Iavg	REAL	Average Phase Current (A)
Out.Vab	REAL	Voltage Vab (V)

Output Parameter	Type	Meaning
Out.Vbc	REAL	Voltage Vbc (V)
Out.Vca	REAL	Voltage Vca (V)
Out.VxAvg	REAL	Average Line Voltage (V)
Out.PF	REAL	Power Factor
Out.KW	REAL	Real Power (KW)
Out.HP	REAL	Real Power (HP)
Out.KVRA	REAL	Reactive Power (KVAR)
Out.KVR	REAL	Apparent Power (KVA)
Out.RTD1_Temp	REAL	RTD #1 Temperature (DegF)
Out.RTD2_Temp	REAL	RTD #2 Temperature (DegF)
Out.RTD3_Temp	REAL	RTD #3 Temperature (DegF)
Out.RTD4_Temp	REAL	RTD #4 Temperature (DegF)
Out.RTD5_Temp	REAL	RTD #5 Temperature (DegF)
Out.RTD6_Temp	REAL	RTD #6 Temperature (DegF)
Out.RTD7_Temp	REAL	RTD #7 Temperature (DegF)
Out.RTD8_Temp	REAL	RTD #8 Temperature (DegF)
Out.RTD9_Temp	REAL	RTD #9 Temperature (DegF)
Out.RTD10_Temp	REAL	RTD #10 Temperature (DegF)
Out.RTD11_Temp	REAL	RTD #11 Temperature (DegF)
Out.RTD12_Temp	REAL	RTD #12 Temperature (DegF)
Out.NextStartRemTim	REAL	Remain Time for next start (Minutes)
Out.PumpVibration	REAL	Pump Vibration Sensor Analog Input 1
Out.MotorVibration	REAL	Motor Vibration Sensor Analog Input 2
Out.CauseOfTrip	REAL	Cause of Last Trip ref. GEK-106491M, F134
Out.Trip_Date_Time	DATE_TIME	Last Trip Date and Time
Out.Date_Time	DATE_TIME	Device Current Date and Time

DATE_TIME Description

Data structure parameters:

Element	Data Type	Meaning
Year	UINT	Year (2000 – 2099)
Month	UINT	Month (1 – 12)
Day	UINT	Day (1 – 31)
Hour	UINT	Hour (0 – 23)
Minute	UINT	Minute (0 – 59)
Second	UINT	Second (0 – 59)

User-Definable Memory Array for SR469

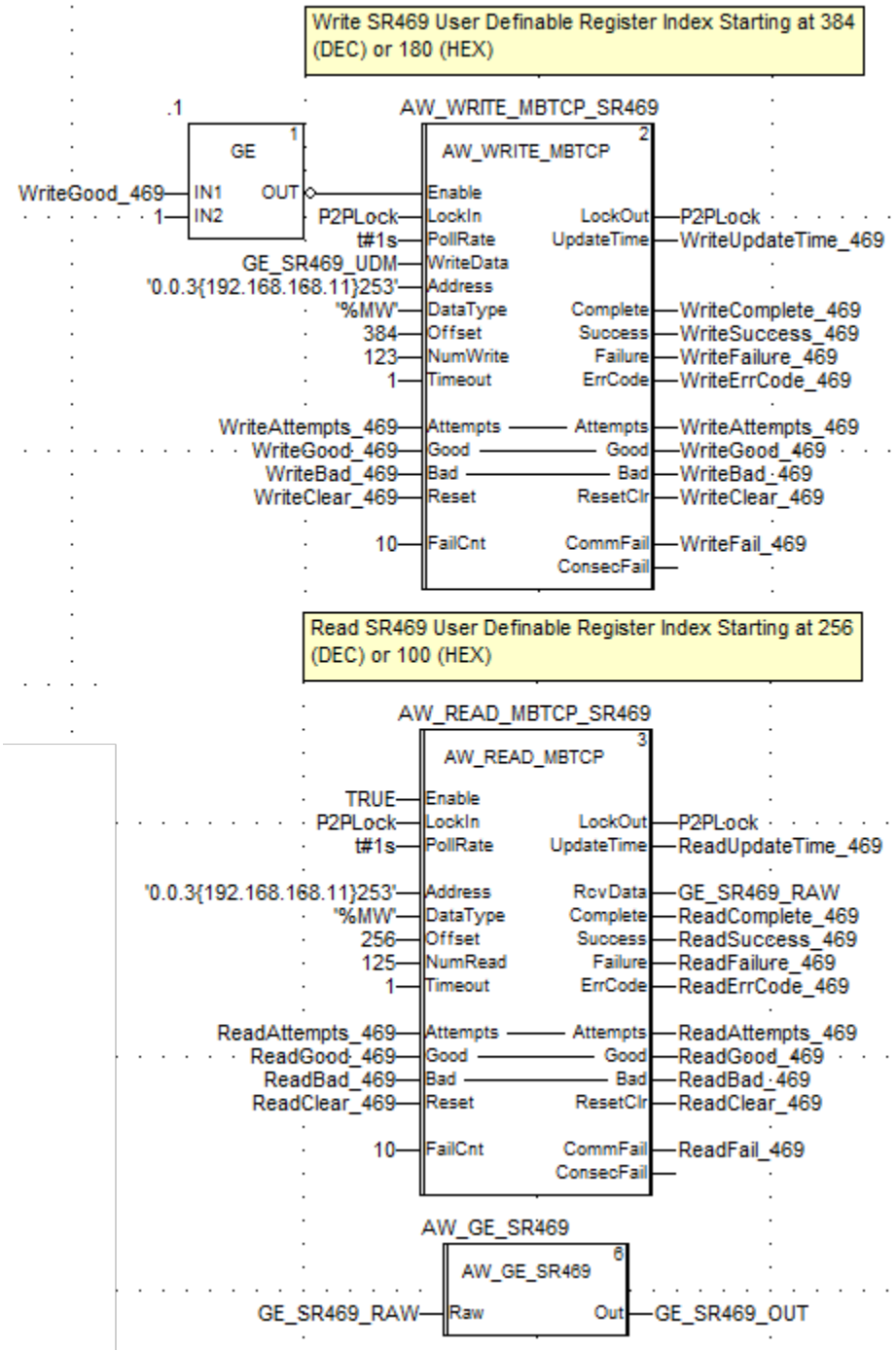
Description of the UDM assignments required for this module to function properly:

User Memory Map Area			SR469 Register Address			
Index	(DEC)	(HEX)	(DEC)	(HEX)	Description	Format
0	384	180	768	0300	Phase A Current (A)	F9
1	385	181	769	0301		
2	386	182	770	0302	Phase B Current (A)	F9
3	387	183	771	0303		
4	388	184	772	0304	Phase C Current (A)	F9
5	389	185	773	0305		
6	390	186	774	0306	Average Current (A)	F9
7	391	187	775	0307		
8	392	188	832	0340	Voltage Vab (V)	F1
9	393	189	833	0341	Voltage Vbc (V)	F1
10	394	18A	834	0342	Voltage Vca (V)	F1
11	395	18B	835	0343	Average Line Voltage (V)	F1
12	396	18C	880	0370	Power Factor (0.01 x PF)	F21
13	397	18D	881	0371	Real Power (0.1 x KW)	F12
14	398	18E	882	0372		
15	399	18F	883	0373	Real Power (HP)	F1
16	400	190	884	0374	Reactive Power (0.1 x KVAR)	F12
17	401	191	885	0375		
18	402	192	886	0376	Apparent Power (KVA)	F1
19	403	193	801	0321	RTD #1 Temperature (degF)	F4
20	404	194	802	0322	RTD #2 Temperature (degF)	F4
21	405	195	803	0323	RTD #3 Temperature (degF)	F4
22	406	196	804	0324	RTD #4 Temperature (degF)	F4
23	407	197	805	0325	RTD #5 Temperature (degF)	F4
24	408	198	806	0326	RTD #6 Temperature (degF)	F4
25	409	199	807	0327	RTD #7 Temperature (degF)	F4
26	410	19A	808	0328	RTD #8 Temperature (degF)	F4
27	411	19B	809	0329	RTD #9 Temperature (degF)	F4
28	412	19C	810	032A	RTD #10 Temperature (degF)	F4
29	413	19D	811	032B	RTD #11 Temperature (degF)	F4

User Memory Map Area			SR469 Register Address			
Index	(DEC)	(HEX)	(DEC)	(HEX)	Description	Format
30	414	19E	812	032C	RTD #12 Temperature (degF)	F4
31	415	19F	691	02B3	Time between Starts Lockout Time (Min)	F1
32	416	1A0	944	03B0	Vibration Analog Input 1 (In/Sec)	F12
33	417	1A1	945	03B1		
34	418	1A2	946	03B2	Vibration Analog Input 2 (In/Sec)	F12
35	419	1A3	947	03B3		
36	420	1A4	544	0220	Cause of Last Trip (ref. GEK-106491M)	F134
37	421	1A5	545	0221	Time of last trip	F19
38	422	1A6	546	0222		
39	423	1A7	547	0223	Date of last trip	F18
40	424	1A8	548	0224		
41	425	1A9	4144	1030	Current Device Date	F18
42	426	1AA	4145	1031		
43	427	1AB	4146	1032	Current Device Time	F19
44	428	1AC	4147	1033		

See 469 Motor Management Relay Communications Guide, GEK-106491M, for additional information on register assignments and associated formats.

Sample Code



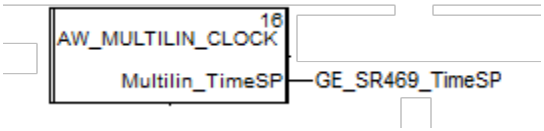
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AW_MULTILIN_CLOCK:

Function Description

The AW_MULTILIN_CLOCK module reads the PLC's current time and date (TOD) and formats the data into the Multilin's broadcast format for clock synchronization.[ii] The PQMII and SR469 TOD broadcast formats are identical. If all the Multilin devices are connected to the same Modbus gateway serially via a RS-485 link, it is possible to perform clock synchronization with a single write command using the Modbus RTU broadcast address of 0. If the devices use an embedded Ethernet controller, then clock synchronization must be done writing to with each Multilin device's unique IP address.

Representation



Parameter Description

Description of the output parameter:

Parameter	Type	Meaning
Multilin_TimeSP	ARRAY[0..3] OF INT	PLC Time formatted for Multilin Devices:
Multilin_TimeSP[0]	INT	1st byte: Month (1 to 12); 2nd byte: Day (1 to 31)
Multilin_TimeSP[1]	INT	3rd & 4th bytes: Year (1995 to 2094)
Multilin_TimeSP[2]	INT	5th byte: Hours (0 to 23); 6th byte: Minutes (0 to 59)
Multilin_TimeSP[3]	INT	7th & 8th bytes: Milliseconds (0 to 59999)

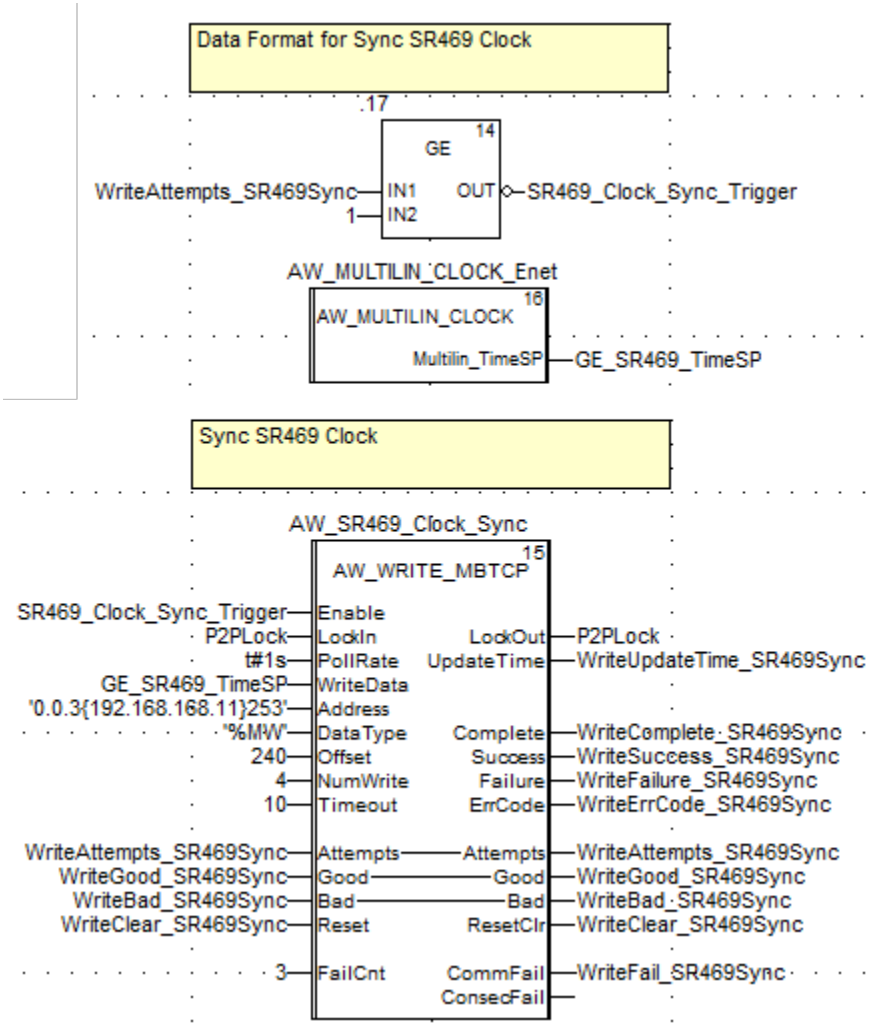
Embedded Modules

None.

Used By Modules

None.

Sample Code



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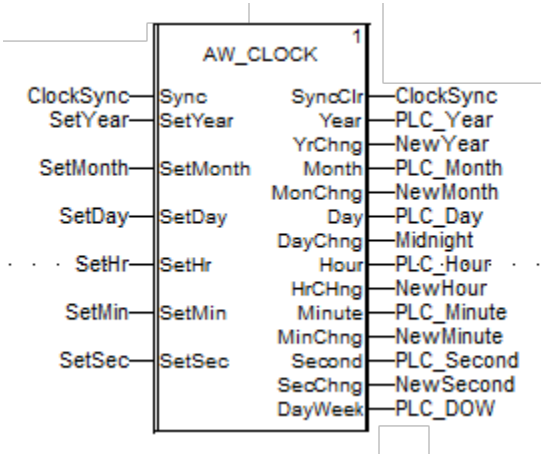
AW_CLOCK: PLC Clock Access

Function Description

This module provides two functions. First accesses the PLC clock and extracts the current date and time into individual tags. In addition, it monitors the clock and generates a pulse at the beginning of each second, minute, hour, day, month, and year. These pulses are active for one program scan.

Secondly, it provides the ability to sync the PLC clock to a specified date and time. The time is updated when the *Sync* signal is set.

Representation



Parameter Description

Input Parameter	Type	Meaning
Sync	EBOOL	Set to update the PLC clock
SetYear	UINT	Desired Year (2000 – 2099)
SetMonth	UINT	Desired Month (1 – 12)
SetDay	UINT	Desired Day (1 – 31)
SetHr	UINT	Desired Hour (0 – 23)
SetMin	UINT	Desired Minute (0 – 59)
SetSec	UINT	Desired Second (0 – 59)

Output Parameter	Type	Meaning
SyncClr	EBOOL	Used to clear the Sync request
Year	UINT	Current year (2000 – 2099)
YrChng	EBOOL	Pulses every year at midnight on January 1
Month	UINT	Current month (1 – 12)
MonChng	EBOOL	Pulses every month at midnight on the first day of the month
Day	UINT	Current day (1 – 31)
DayChng	EBOOL	Pulses every day at midnight
Hour	UINT	Current hour (0 – 23)
HrChng	EBOOL	Pulses at the top of every hour
Minute	UINT	Current minute (0 – 59)
MinChng	EBOOL	Pulses at the start of every minute
Second	UINT	Current second (0 – 59)
SecChng	EBOOL	Pulses every second
DayWeek	UINT	Current day of the week (1 = Sunday, 7 = Saturday)

Embedded Modules

AW_GET_TOD – Reads current PLC Clock.

AW_SET_TOD – Sets PLC Clock to Date/Time specified.

R_TRIG – Detects Year, Month, Day, Hour, Minute and Second changes.

Used By Modules None

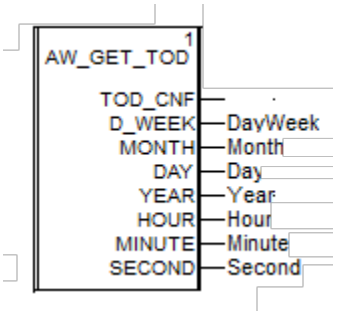
Top of the Document

AW_GET_TOD: Reads the Current PLC Clock

Function Description

This block provides a procedural interface to the PLC clock. It exposes the clock values similar to the GET_TOD module that was available under the Concept programming package.

Representation



Parameter Description

Output Parameter	Type	Meaning
TOD_CNF	BOOL	Set when the PLC clock is operational Reset when the clock is being updated
D_WEEK	UINT	Current day of the week 1 = Sunday, … 7 = Saturday
MONTH	UINT	Current month (1 – 12)
DAY	UINT	Current day (1 – 31)
YEAR	UINT	Current year (2000 – 2099)
HOUR	UINT	Current hour (0 – 23)
MINUTE	UINT	Current minute (0 – 59)
SECOND	UINT	Current second (0 – 59)

Embedded Modules

RRTC_DT – Reads the PLC clock.

Used By Modules

AW_CLOCK – Reads current date and time.

AW_MIN_MAX – Records when Minimum or Maximum occurred.

AW_RT_STARTS – Reads date and time when equipment started or runtime reset.

AW_RUNTIME – Reads date and time when equipment started or runtime reset.

AW_SCHEDULE – Reads current date and time.

AW_TOTAL – Reads when total is reset.

AW_TOTALIZE – Reads current date and time to reset daily and monthly values.

AW_TRANSITIONS – Reads date and time when equipment opened or open time reset.

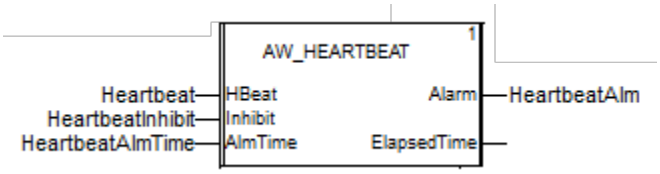
Top of the Document

AW_HEARTBEAT: Monitor a Heartbeat Register

Function Description

Monitor the status of a Heartbeat register. Peer-to-Peer messages may include a Heartbeat register that should always be changing. If it stops changing, then the communication stopped working. The Alarm is reset once a change is detected.

Representation



Parameter Description

Description of the input parameters:

Parameter	Type	Meaning
HBeat	UINT	Register that should be changing during normal conditions
Inhibit	BOOL	Set to inhibit heartbeat monitoring (default = Enabled)
AlmTime	TIME	Amount of time Heartbeat must be constant before the Alarm is generated (default = 60 sec)

Description of the output parameters:

Parameter	Type	Meaning
Alarm	EBOOL	Set when Heartbeat stops changing for the time specified
ElapsedTime	TIME	How long since the Heartbeat stopped changing

Embedded Modules

TON – Times how long *HBeat* has not changed.

Used By Modules None

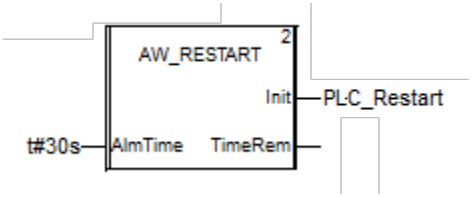
Top of the Document

AW_RESTART: Monitor PLC Startup

Function Description

Generates an alarm indication whenever the PLC initially starts. Restart can be due to a warm start, cold start, or stopping and starting the program.

Representation



Parameter Description

Input Parameter	Type	Meaning
AlmTime	TIME	How long to generate the alarm indication when a restart is detected

Output Parameter	Type	Meaning
Init	EBOOL	Set when a restart is detected. It automatically resets after the time specified
TimeRem	TIME	Provides the elapsed time of how long the alarm has been active

Embedded Modules

TP – Times how long *Init* to stay active.

Used By Modules None.

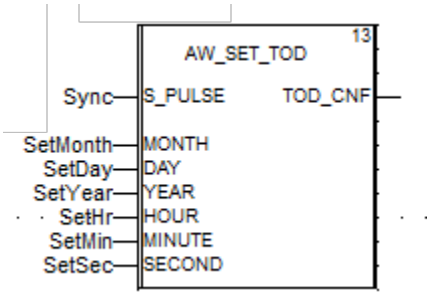
Top of the Document

AW_SET_TOD: Updates the PLC Clock

Function Description

This block provides a procedural interface to the PLC clock. It allows the clock to be set like the SET_TOD module that was available under the Concept programming package.

Representation



Parameter Description

Input Parameter	Type	Meaning
S_PULSE	BOOL	Set to update PLC clock with specified values
MONTH	UINT	Desired month (1 – 12)
DAY	UINT	Desired day (1 – 31)
YEAR	UINT	Desired year (2000 – 2099)
HOUR	UINT	Desired hour (0 – 23)
MINUTE	UINT	Desired minute (0 – 59)
SECOND	UINT	Desired second (0 – 59)

Output Parameter	Type	Meaning
TOD_CNF	BOOL	Set when the PLC clock is operational. Reset when the clock is being updated.

Embedded Modules

WRTC_DT – Updates PLC clock with specified date and time.

Used By Modules None.

Top of the Document

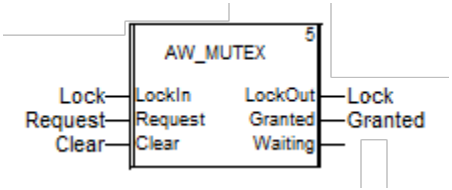
AW_MUTEX: Mutual Exclusion

Function Description

This block determines mutually exclusive access for logic. There are times when certain devices in the system need to be controlled one at a time. For example, this block can be used for polling one device a time to avoid packet collisions.

To determine exclusive access, a common Lock must be used by all the associated Mutexes. This allows each Mutex to request access to the common resource in an asynchronous manner. Once the Mutex is granted, it is the responsibility of the user to clear the Mutex once it is done with the resource. If the Mutex is not released properly, the resource may become unavailable.

Representation



Parameter Description

Input Parameter	Type	Meaning
LockIn	EBOOL	Current Locked Status (1 = Lock Active).
Request	EBOOL	Requests exclusive access to the lock (1 = Request).
Clear	EBOOL	Removes exclusive access to the Lock (1 = Clear).

Output Parameter	Type	Meaning
LockOut	EBOOL	Current Lock Status (1 = Lock Active).
Granted	EBOOL	Set when exclusive access is granted (1 = Granted).
Waiting	EBOOL	Set if waiting for exclusive access (1 = Waiting).

Embedded Modules

SR – Used to remember Request.

Used By Modules

AW_READ340_MBTCP – Used to gain exclusive access to network link.

AW_READ580_MBTCP – Used to gain exclusive access to network link.

AW_WRITE340_MBTCP – Used to gain exclusive access to network link.

AW_WRITE580_MBTCP – Used to gain exclusive access to network link.

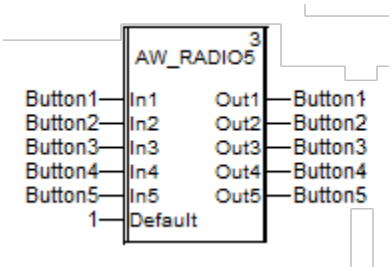
Top of the Document

AW_RADIO5: Select One of Five Inputs

Function Description

Selects one of five inputs. Selection is performed like radio pushbuttons. When one input is selected, the other inputs are cleared. The *Default* input specifies which input will be selected if none of the inputs are active.

Representation



Parameter Description

Input Parameter	Type	Meaning
In1	EBOOL	Option 1
In2	EBOOL	Option 2
In3	EBOOL	Option 3
In4	EBOOL	Option 4
In5	EBOOL	Option 5
Default	UINT	Default input of none is selected (1 – 5)

Output Parameter	Type	Meaning
Out1	EBOOL	Option 1
Out2	EBOOL	Option 2
Out3	EBOOL	Option 3
Out4	EBOOL	Option 4
Out5	EBOOL	Option 5

Embedded Modules

None.

Used By Modules None.

Top of the Document

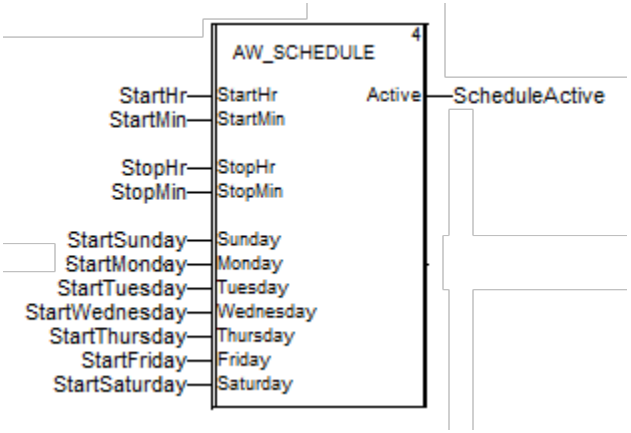
AW_SCHEDULE: Schedule an Event based upon PLC Clock

Function Description

Provides a means to schedule an activity to start and stop at a specific time each day. If the stop time is before the start time, then it is assumed the stop time is on the next day.

The schedule can be configured to be valid on specific days of the week, if desired. The valid day applies to the start time. Once started, the schedule is active until the stop time is reached.

Representation



Parameter Description

Description of the input parameters:

INPUT Parameter	Type	Meaning
StartHr	UINT	Hour to start the event (0 - 23).
StartMin	UINT	Minute to start the event (0 - 59).
StopHr	UINT	Hour to stop the event (0 - 23).
StopMin	UINT	Minute to stop the event (0 - 59).
Sunday	BOOL	Set if event can start on a Sunday (default = True).
Monday	BOOL	Set if event can start on a Monday (default = True).
Tuesday	BOOL	Set if event can start on a Tuesday (default = True).
Wednesday	BOOL	Set if event can start on a Wednesday (default = True).
Thursday	BOOL	Set if event can start on a Thursday (default = True).

INPUT Parameter	Type	Meaning
Friday	BOOL	Set if event can start on a Friday (default = True).
Saturday	BOOL	Set if event can start on a Saturday (default = True).

Description of the output parameters:

OUTPUT Parameter	Type	Meaning
Active	BOOL	Set when schedule is active. PLC clock is between specified Start and Stop times.

Embedded Modules

AW_GET_TOD – Reads current date and time.

Used By Modules None.

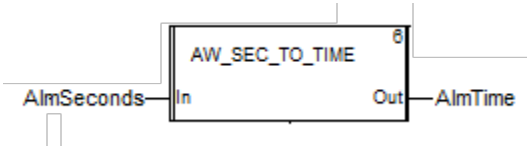
Top of the Document

AW_SEC_TO_TIME: Convert Seconds to TIME Format

Function Description

Converts specified number of seconds to internal TIME format. Maximum number of seconds is 65535, which equates to 18 hours, 12 minutes and 15 seconds.

Representation



Parameter Description

Input Parameter	Type	Meaning
In	UINT	Number of seconds to convert (0 – 65535)

Output Parameter	Type	Meaning
Out	TIME	Converted seconds (t#0s – t#18h_12m_15s)

Embedded Modules

None.

Used By Modules

AW_AA – Converts delay time to TIME format.

AW_ERR_CTRL – Converts input times to TIME format.

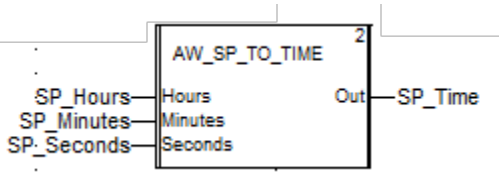
Top of the Document

AW_SP_TO_TIME: Convert Time Setpoints to Internal TIME Format

Function Description

Converts specified number of hours, minutes, and seconds to internal TIME format. Maximum number of hours is 1000, minutes is 1440, and seconds is 65535, which equates to 43 days, 10 hours, 12 minutes, and 15 seconds.

Representation



Parameter Description

Input Parameter	Type	Meaning
Hours	UINT	Desired number of hours (0 – 1000 hours).
Minutes	UINT	Desired number of minutes (0 – 1440 minutes).
Seconds	UINT	Desired number of seconds (0 – 65535 seconds).

Output Parameter	Type	Meaning
Out	TIME	Converted setpoint (t#0s – t#43d_10h_12m_15s).

Embedded Modules

None.

Used By Modules

None.

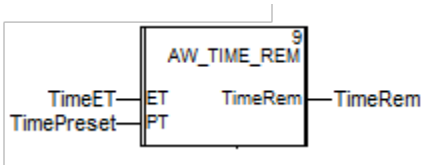
Top of the Document

AW_TIME_REM: Calculate Time Remaining in Number of Seconds

Function Description

Calculates the number of seconds remaining (countdown timer) between a preset value and the elapsed time. Maximum supported time is 18 hours, 12 minutes and 15 seconds.

Representation



Parameter Description

Input Parameter	Type	Meaning
ET	TIME	Elapsed Time (t#0s – t#18h_12m_15s)
PT	TIME	Timer Preset (t#0s – t#18h_12m_15s)

Output Parameter	Type	Meaning
TimeRem	UINT	Remaining number of seconds (0 – 65535 seconds)

Embedded Modules

AW_TIME_TO_SEC – Converts time remaining to number of seconds.

Used By Modules

AW_AA – Calculates time remaining until alarm is active.

AW_ERR_CTRL – Calculates time remaining until control fault.

AW_MODGATE – Calculates time remaining until travel fault.

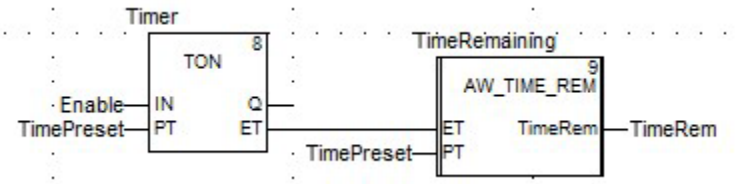
AW_MODVLV – Calculates time remaining until travel fault.

AW_MOTOR – Calculates time remaining until control fault.

AW_VALVE – Calculates time remaining until control fault.

AW_VFD – Calculates time remaining until control fault.

Sample Code



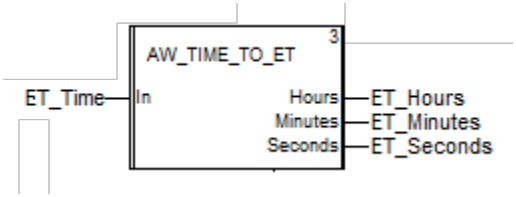
Top of the Document

AW_TIME_TO_ET: Convert Time to Hours, Minutes and Seconds

Function Description

Converts internal TIME to the corresponding number of hours, minutes, and seconds. Maximum time is 49 days, 17 hours, 2 minutes, and 47 seconds.

Representation



Parameter Description

Input Parameter	Type	Meaning
In	TIME	Converted setpoint (t#0s – t#49d_17h_2m_47s).

Output Parameter	Type	Meaning
Hours	UINT	Elapsed number of hours (0 – 1193 hours).
Minutes	UINT	Elapsed number of minutes (0 – 2 minutes).
Seconds	UINT	Elapsed number of seconds (0 – 47 seconds).

Embedded Modules

None.

Used By Modules None.

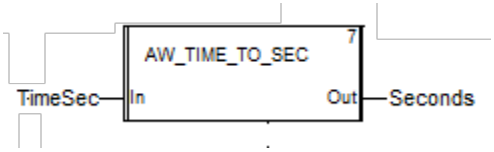
Top of the Document

AW_TIME_TO_SEC: Convert TIME to number of Seconds

Function Description

Converts internal TIME to the corresponding number of seconds. Maximum number of seconds is 65535, which equates to 18 hours, 12 minutes and 15 seconds. Note that during the conversion fractional seconds are truncated, i.e. t#5m_2s_789ms converts to 302 seconds.

Representation



Parameter Description

Input Parameter	Type	Meaning
In	TIME	Time to convert (t#0s – t#18h_12m_15s)

Output Parameter	Type	Meaning
Out	UINT	Converted seconds (0 – 65535 seconds)

Embedded Modules

None

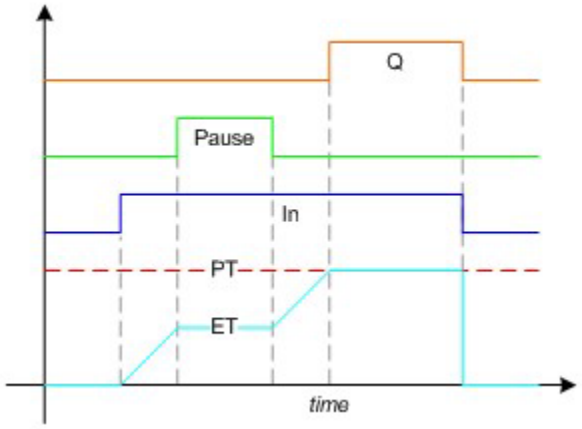
Used By Modules None

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AW_TON_P: On Delay with Pause

Function Description

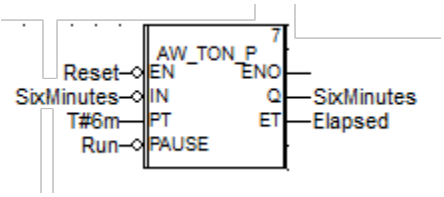
The function block is used as an On delay. A 0 ➈ 1 transition on the input starts the timer function. A 1 ➈ 0 transition resets the timer. If the elapsed time (output *ET*) reaches the value defined on input *PT*, output *Q* is set to "1".



When the function block is first called the initial state of *ET* is "0". With a "1" signal on input *PAUSE*, the timer is stopped and all values are frozen. If the input *PAUSE* becomes "0" again, the timer continues.

PAUSE has the highest priority. With a 1 ➈ 0 edge on input *PAUSE*, the block is no longer processed in this cycle. The block continues processing in the next cycle.

Representation



Parameter Description

Input Parameter	Type	Meaning
IN	EBOOL	Timing starts when input signal is set.
PT	TIME	Preset time on-delay.
PAUSE	EBOOL	Pause accumulating delay time. (1 = Pause).

Output Parameter	Type	Meaning
Q	EBOOL	Set when accumulated time has reached the preset time.
ET	TIME	Accumulated time since input was active. Stops accumulating once preset time is reached.

Embedded Modules

TON – Maintains accumulated elapsed time.

Used By Modules

AW_MODGATE – Times how long gate has been moving.

AW_RT_STARTS – Reads date and time when equipment started or runtime reset.

AW_RUNTIME – Reads date and time when equipment started or runtime reset.

Top of the Document

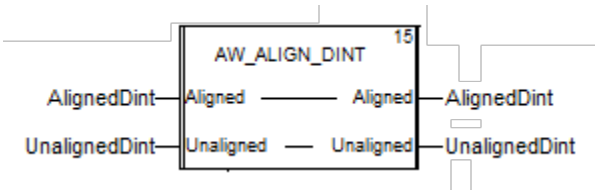
AW_ALIGN_DINT: Align Quantum DINT with X80 DINT Variable

Function Description

Due to data alignment differences between Quantum and X80 CPUs, 32-bit values may be misaligned when converting from Quantum to X80. X80 CPUs must have 32-values (REAL, DINT, UDINT, etc) on an even address. Quantums do not have any constraint on the address.

Due to special circumstances, it may be necessary to maintain the original Quantum address after the conversion. This module allows the unaligned Quantum Address to be maintained while the aligned address can be used by the X80 logic. The unaligned address can continue to be read or written by external devices (HMI, OIT, peer-to-peer PLCs).

Representation



Parameter Description

Parameter	Type	Meaning
Aligned	DINT	Aligned DINT. May be a located or unlocated variable.
Unaligned	ARRAY[0..1] OF WORD	Unaligned DINT located at previous Quantum address.

Embedded Modules

None

Used By Modules None

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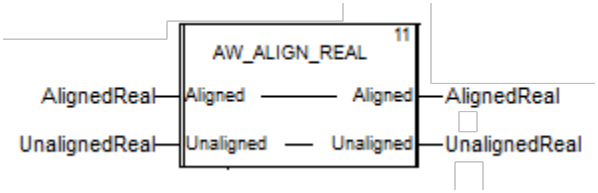
AW_ALIGN_REAL: Align Quantum REAL with X80 REAL Variable

Function Description

Due to data alignment differences between Quantum and X80 CPUs, 32-bit values may be misaligned when converting from Quantum to X80. X80 CPUs must have 32-values (REAL, DINT, UDINT, etc) on an even address. Quantums did not have any constraint on the address.

Due to special circumstances, it may be necessary to maintain the original Quantum address after the conversion. This module allows the unaligned Quantum Address to be maintained while the aligned address can be used by the X80 logic. The unaligned address can continue to be read or written by external devices (HMI, OIT, peer-to-peer PLCs).

Representation



Parameter Description

Parameter	Type	Meaning
Aligned	REAL	Aligned REAL. May be a located or unlocated variable.
Unaligned	ARRAY[0..1] OF WORD	Unaligned REAL located at previous Quantum address.

Embedded Modules

None

Used By Modules None

Top of the Document

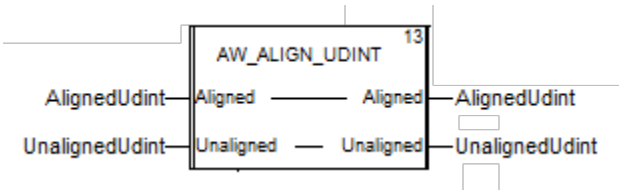
AW_ALIGN_UDINT: Align Quantum UDINT with X80 DINT Variable

Function Description

Due to data alignment differences between Quantum and X80 CPUs, 32-bit values may be misaligned when converting from Quantum to X80. X80 CPUs must have 32-values (REAL, DINT, UDINT, etc) on an even address. Quantum PLCs did not have any constraint on the address.

Due to special circumstances, it may be necessary to maintain the original Quantum address after the conversion. This module allows the unaligned Quantum Address to be maintained while the aligned address can be used by the X80 logic. The unaligned address can continue to be read or written by external devices (HMI, OIT, peer-to-peer PLCs).

Representation



Parameter Description

Parameter	Type	Meaning
Aligned	UDINT	Aligned UDINT. May be a located or unlocated variable.
Unaligned	ARRAY[0..1] OF WORD	Unaligned UDINT located at previous Quantum address.

Embedded Modules

None

Used By Modules None

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Installing the AW_Family DFB Library

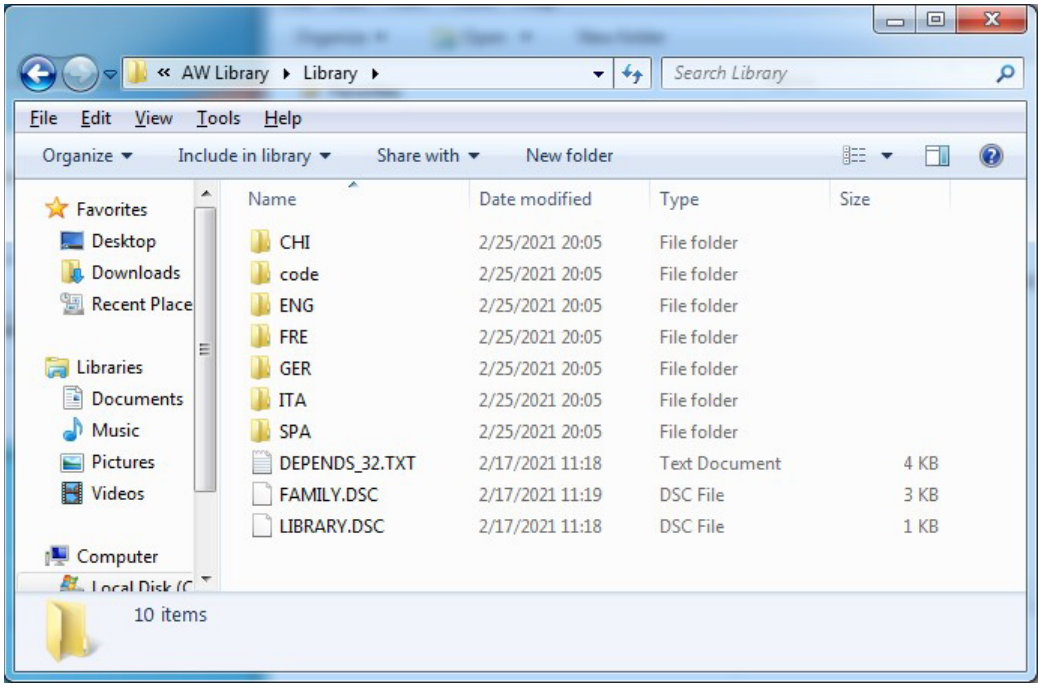
Introduction

This section describes steps to install Unity Pro Library. Steps outline will allow users to install the Austin Water (AW) DFB block into a Unity Pro system where users can access the DFB in their programming environment and block's help files with ease. Although Unity Pro provides tool to install the custom library, but the tool "Types Library Update" utility provided did not handle the help files graphic correctly. Steps below will describe the installation procedure and to overcome the Unity Library tool shortcoming.

Unzipping the DFB Package Provided

Obtain the latest "AW Library.zip" file then copy it onto a computer that has Schneider Control Expert and/or Unity Pro software. Select a convenient destination directory where you can Unzip the "AW Library.zip" file.

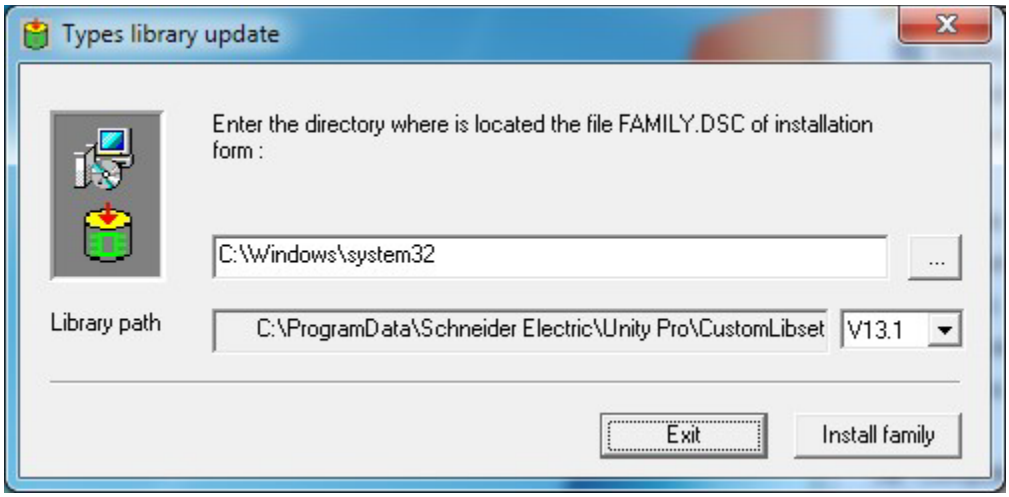
The folder should look similar to this.



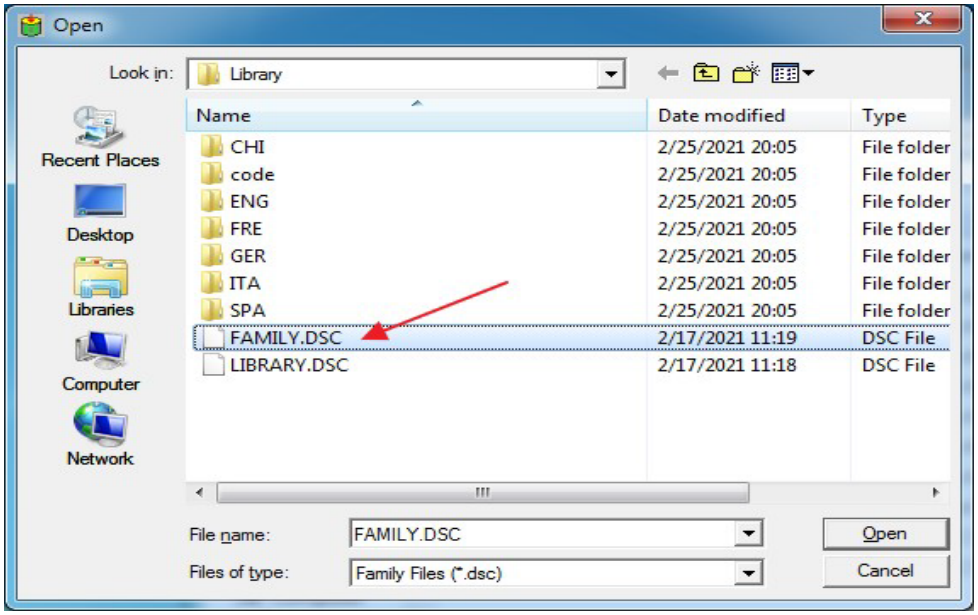
For the example above, files are located at "C:\AW Library", make note of the path information for next step.

Using the Unity Pro Types Library Update Tool

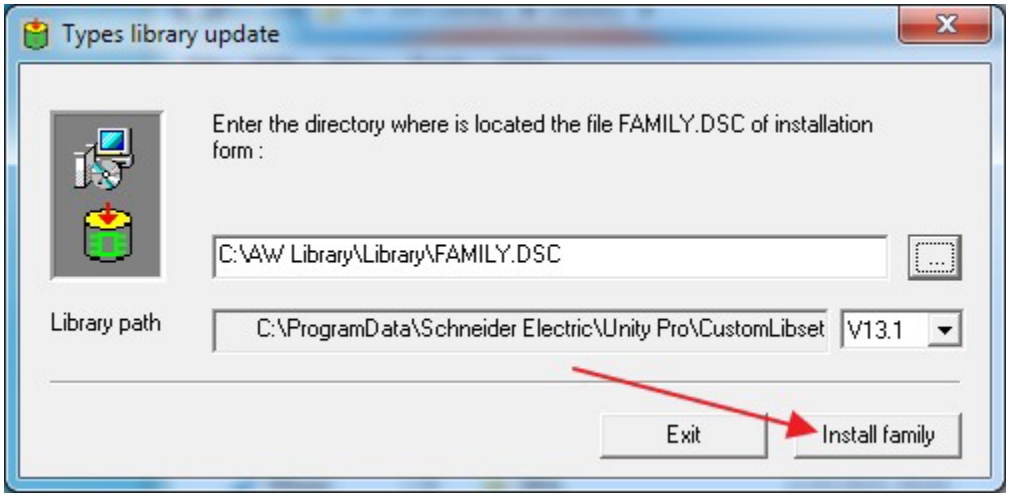
Ensure that Schneider Unity Pro is not running, then from the Windows Start menu, navigate to "All Programs" → "Schneider Electric" → "SoCollaborative" → "Unity Pro" → "Types Library Update".



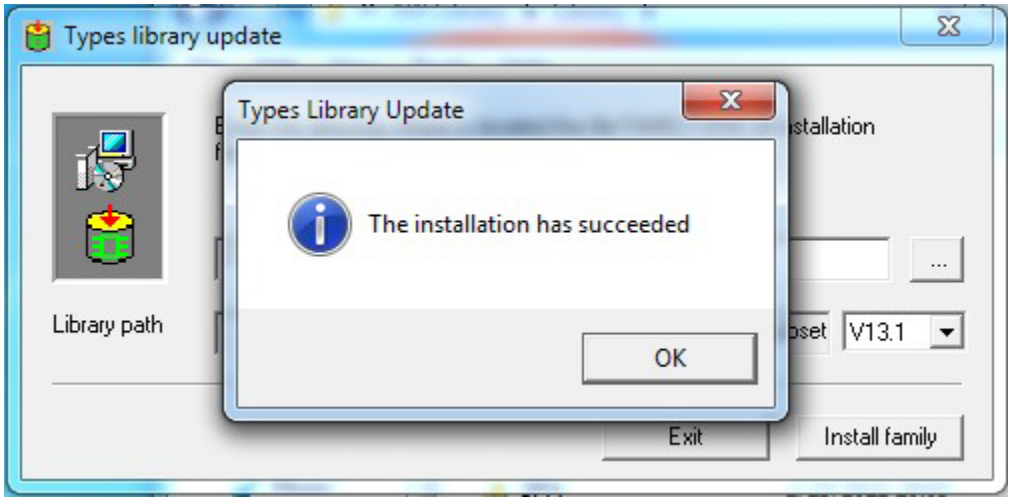
Click on the ellipsis "…" button then under the "Open" dialogue box, navigate to the library folder path noted on the previous step then select the "FAMILY.DSC" file and click "Open"



Then click the "Install family" button.

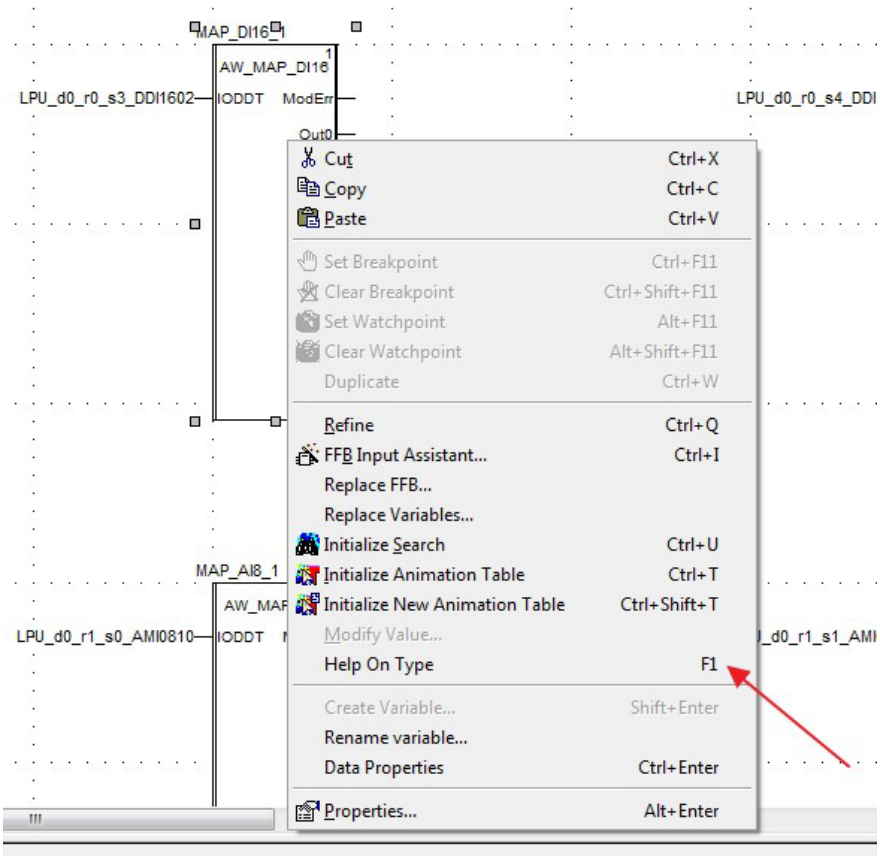


The installation has succeeded should appear.

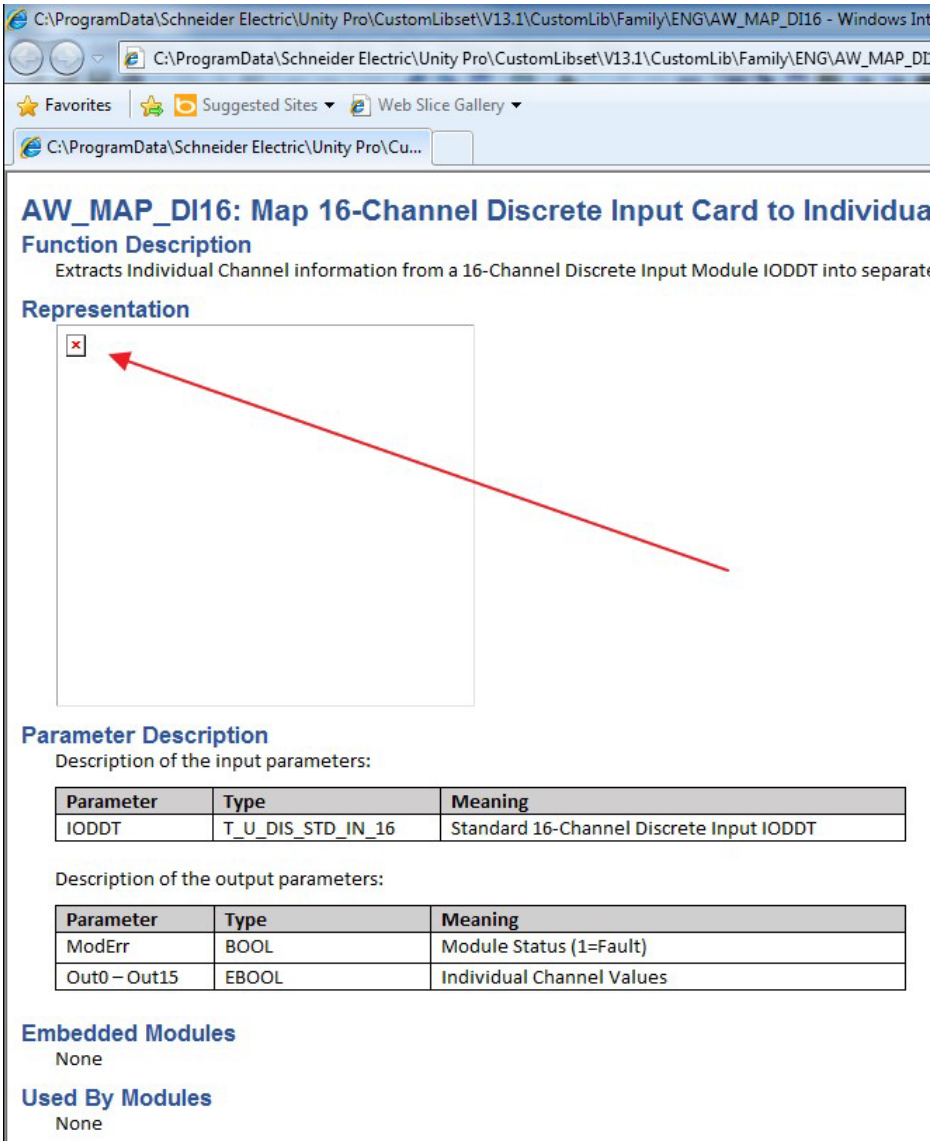


Exit out the “Types library update” utility

Run Unity Pro, if viewing the demo project is desire then open the “awu u13 m340 v1.sta” file for the demo project. Highlight any of the AW function block, and right click on the block then navigate to “Help On Type F1” or simply hit the “F1” key on the keyboard.



The associated help for the block will appear on the web browser with missing graphic.



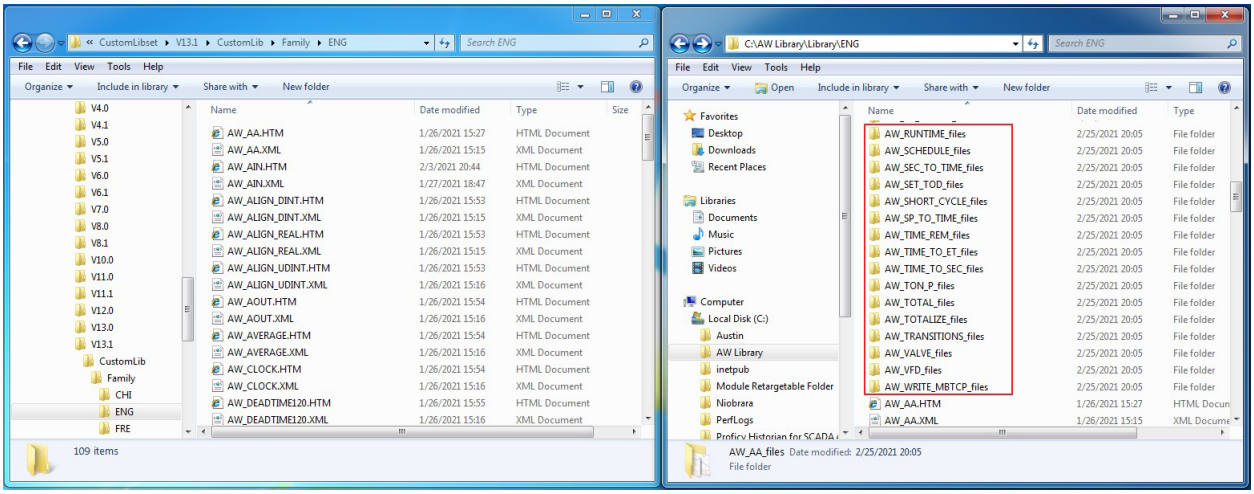
To correct the missing graphic issue, navigate to the custom library path. For Unity Pro V13, the custom library path is located at "C:\ProgramData\Schneider Electric\Unity

Pro\CustomLibset\V13.1\CustomLib\Family\ENG" and compare to the original unzipped "AW

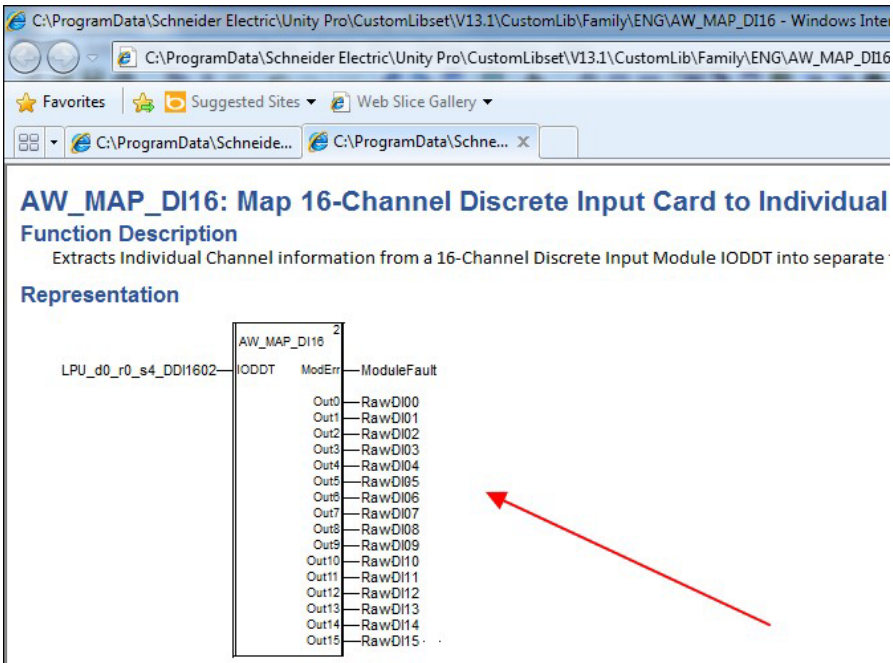
Library" folder. The Unity Pro "Types Library Update" tool fail to copy the graphic files associated with the block into the folder. Simply select all the AW_*_ files folder (* indicated all the folder for

the associated DFBs) and copy it into the "C:\ProgramData\Schneider Electric\Unity

Pro\CustomLibset\V13.1\CustomLib\Family\ENG" path as shown in the graphic below.



Then navigate back to Unity Pro and bring the help up on any of the custom AW block. The correct help information with graphic will show.



AW_MAP_DI16: Map 16-Channel Discrete Input Card to Individual

Function Description

Extracts Individual Channel information from a 16-Channel Discrete Input Module IODDT into separate

Representation

Parameter Description

Description of the input parameters:

Parameter	Type	Meaning
IODDT	T_U_DIS_STD_IN_16	Standard 16-Channel Discrete Input IODDT

Description of the output parameters:

Parameter	Type	Meaning
ModErr	BOOL	Module Status (1=Fault)
Out0 – Out15	EBOOL	Individual Channel Values

Embedded Modules

None

Used By Modules

None

Installing AW_FAMILY DFB's in Control Expert

1. Follow Unity Library Install Instructions.
    a. Note that for Control Expert, *the Types Library Update application is in folder Ecostruxure Control Expert in the start menu*.
    b. This makes the DFBs available in the software.
2. Some of these DFBs use dynamic arrays:
    a. If attempting to build and errors are present stating that dynamic arrays are not allowed:
        i. Enable dynamic arrays: Tools -> Project Settings -> Variables -> Allow dynamic arrays.
        ii. If this was not enabled, it does require an offline build.

NOTE: If Linker Errors occur on build, use the following procedure.

CE 15.n Linker Errors

1. Open sta, updating version to latest available
2. Attempt to build all -> this is where the linker errors will show up in the output window
3. TOOLS -> TYPES LIBRARY MANAGER -> ACCESS ASST BUTTON
    a. Open v15.3 library
    b. Click any FB and CTRL + A
    c. Click >> to add to project
    d. Copy to project button -> this takes a while
    e. If pop up says some exist, select one then CTRL + A
        i. Ok
        ii. Be patient
    f. Error message -> compatibility checks
        i. OK
    g. Close the types library manager
4. May need to enable the use of dynamic libraries: Tools -> Project Settings -> Variables, "Allow dynamic arrays"
5. Rebuild all, should be good

Top of the Document

[i] 869 Motor Protection System Instruction manual GE publication code: 1601-0450-AH, page 181, compatibility [ii] 469 Motor Management Relay Instruction Manual P/N: 1601-0057-DH (GEK-106289J), page 176, commands (Addresses 0080-00FF), F24, F18

PQMII Power Quality Meter Communication Guide Manual P/N: 1601-9090-A1 (GEK-113532), page 19, broadcast command (Holding Registers) Addresses 00F0-00FF), F22, F23, F24, F25

Appendix C: OIU PLC Time Sync Method

Provide the following configuration on OIU and PLC program to use the PLC date/time to sync the OIU clock. In the Vijeo Designer:

1. Check the box in the top left corner to enable the dialog table.
2. Input a memory word address in the Start Address field. The memory word address should be an address in the PLC processor that is not used in the logic.
3. Select the Add button.
4. Scroll to the 33rd function called Set terminal clock. Keep in mind that the Set PLC clock takes up 4 words.
5. Change the Time format for the Terminal to BCD.
6. Then select OK

In the example shown in Figure 41, by inputting %MW100, four words will be allocated, %MW100-103.

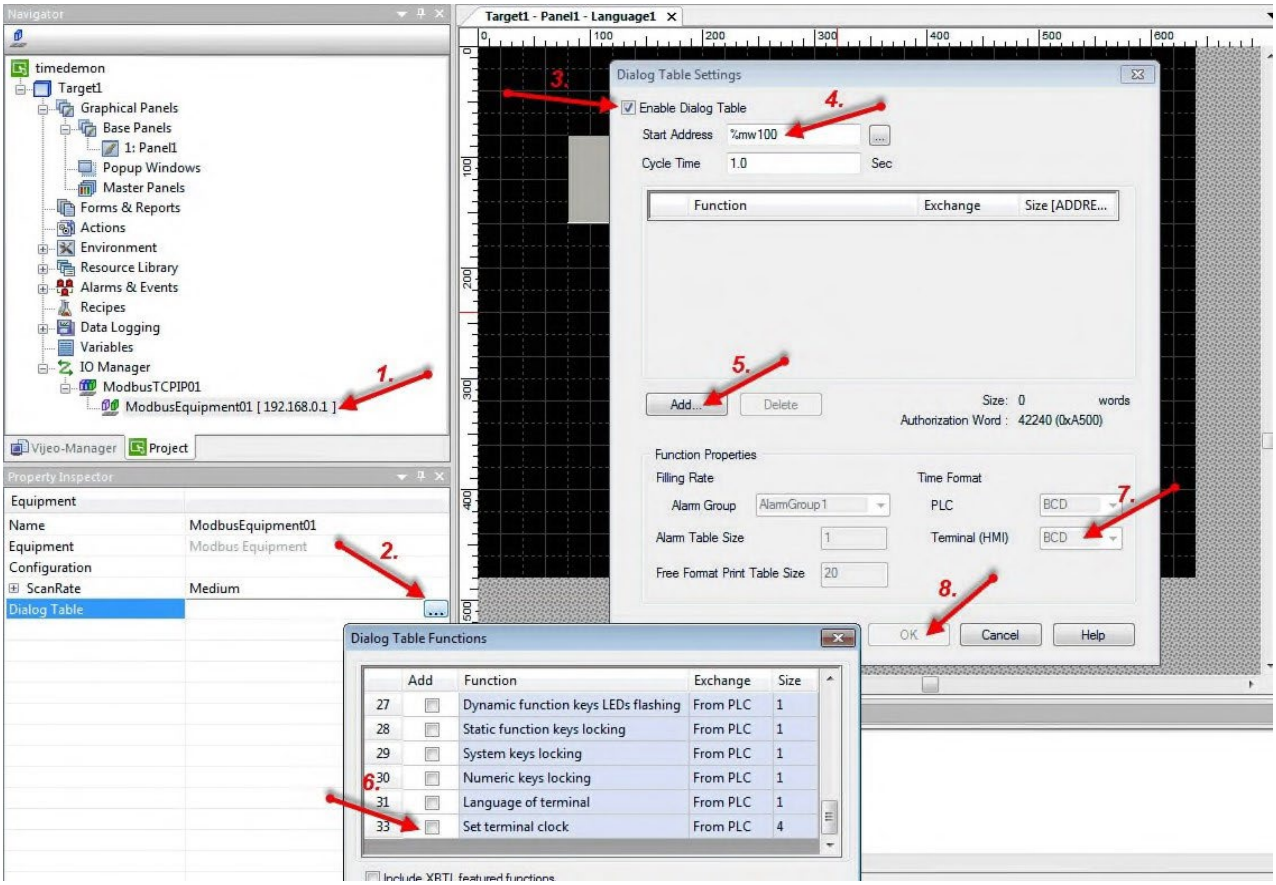


Figure 39 OIU Time Sync Setup in Control Expert

1. Create a variable, name it what you like, and select "DT" as the Type.
2. Use the same address that you called out in Vijeo Designer.
3. Create or add to a FBD section. Place a block called "RRTC_DT"
4. Connect the variable that you created to the out pin.

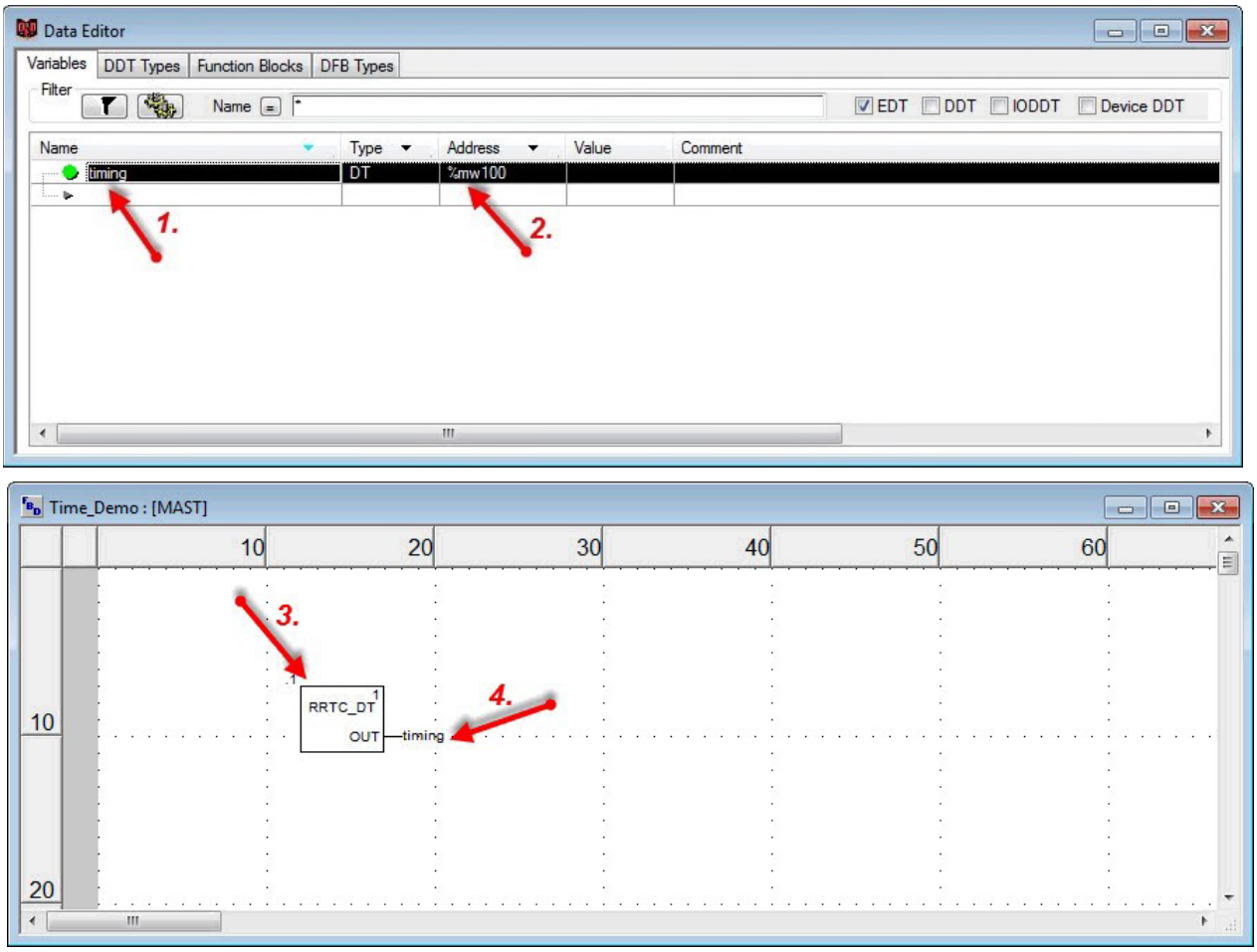


Figure 40 PLC Time Sync Setup

Build and download both projects and you will find that the time on the Harmony OIU now reflects the time on the M580/M340.

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Appendix D. PLC Setup Preferences

The following table lists setup requirements for new / upgrade Schneider PLC's that will be installed in Austin Water sites.

Table 14 Austin Water PLC Setup Preferences for M340s and M580s

No.	Task	M340	M580
1	Modules connected to the SCADA network: **Set the gateway.**	✔	✔
2	Modules connected to the SCADA network: **Enable NTP:** - IP address is the plant PLC gateway. - Set the polling rate to 120 seconds. - Time Zone: -6 Chicago - Enable automatic DST adjustment	✔	✔
3	BME NOC 03x1 modules used with an M580 must be chosen as BME NOC 03x1.4 in the program. This makes the option of updating the processor time available. - The software only allows one NOC to update the processor. This should be the NOC with the lower IP address. - Disable security for the module in the DTM browser	n/a	✔
4	Modules connected to the SCADA network: **Set up SNMP:** Community Names ○ **SET:** blank ○ **GET:** S01arwinds2PLC (*that is zero one)* ○ **Trap:** blank	✔	✔
5	Processor Property Page - **Enable the PLC to start in RUN** - **Initialize %MWi on cold start NOT checked!**	✔	✔
6	Processor Property Page - **Enable online modification in RUN or STOP**	n/a	✔
7	Tools → Project Settings →General: - →Build Setting → **Enable Create New Data Block online.** - → PLC Embedded Data → **Enable Data Dictionary** - → Time → **Verify Time Zone and DST are correct**	✔	✔
8	Tools → Project Settings → Variables: **Allow Dynamic Arrays**	✔	✔
9	Tools → Project Settings → Program → Languages: - At a minimum, **enable FBD, LD, and ST**	✔	✔
10	Check for and **install latest firmware updates, particularly for communication modules.**	✔	✔

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Appendix CP-01: BFP EFFLUENT LIFT STATION

REFERENCE DOCUMENTS:

Document Number	Document Title	Date
03-I-601	P&ID – BFP Effluent Lift Station	
	Motor Control Schematic	

LIST OF EQUIPMENT AND INSTRUMENTATION:

Equipment Field Tag	Equipment Description
LSPUMP-01	BFP Effluent Pump No 1
LSPU1-TS-01	BFP Effluent Pump No 1 Motor Winding High Temp Switch
LSPU1-MSH-01	BFP Effluent Pump No 1 Pump Leak
LSPU1-PI-01	BFP Effluent Pump No 1 Discharge Pressure Gauge
LSPUM-02	BFP Effluent Pump No 2
LSPU2-TS-01	BFP Effluent Pump No 2 Motor Winding High Temp Switch
LSPU2-MSH-01	BFP Effluent Pump No 2 Pump Leak
LSPU2-PI-01	BFP Effluent Pump No 2 Discharge Pressure Gauge
LSPUMP-03	BFP Effluent Pump No 3
LSPU3-TS-01	BFP Effluent Pump No 3 Motor Winding High Temp Switch
LSPU3-MSH-01	BFP Effluent Pump No 3 Pump Leak
LSPU3-PI-01	BFP Effluent Pump No Discharge Pressure Gauge
WW1-LSH-01	BFP Wet Well High Level Switch 1
WW1-LSH-02	BFP Wet Well High Level Switch 2
WW1-LSH-03	BFP Wet Well High Level Switch 3
WW1-LSHH-01	BFP Wet Well High High Level Switch
WW1-LSLL-01	BFP Wet Well Low Low Level Switch
WW1-LIT-01	BFP Wet Well Level Transmitter
LSPI1-PV-01	BFP Discharge plug valve to ARF EQ Basin – normally open
LSPI1-PV-02	Discharge plug valve to Pond 1/SSTP – normally closed
LSPI1-PV-03	Discharge plug valve to Pond 1/SSTP – normally closed
LSPI3-PV-01	ARF Effluent Lift Station Discharge plug valve to Pond 1/SSTP – normally open
	Existing BFP Effluent Lift Station Flow meter

LIST OF ALARMS

TAG	Description	Priority	Alarm Delay
LSPU1-YA-01A-A	BFP Effluent Pump 1 Fail To Run		
LSPU1-YA-01A-B	BFP Effluent Pump 1 Fail To Stop		
LSPU1-TAH-01	BFP Effluent Pump 1 High Temp		
LSPU1-MAH-01	BFP Effluent Pump 1 Leak		
LSPU1-YA-01A	BFP Effluent Pump 1 Fail		
LSPU1-YA-01B	BFP Effluen Pump 1 Estop		
LSPU2-YA-01A-A	BFP Effluent Pump 2 Fail To Run		
LSPU2-YA-01A-B	BFP Effluent Pump 2 Fail To Stop		
LSPU2-TAH-01	BFP Effluent Pump 2 High Temp		
LSPU2-MAH-01	BFP Effluent Pump 2 Leak		
LSPU2-YA-01A	BFP Effluent Pump 2 Fail		
LSPU2-YA-01B	BFP Effluent Pump 2 Estop		
LSPU3-YA-01A-A	BFP Effluen Pump 3 Fail To Run		
LSPU3-YA-01A-B	BFP Effluen Pump 3 Fail To Stop		
LSPU3-TAH-01	BFP Effluent Pump 3 High Temp		
LSPU3-MAH-01	BFP Effluent Pump 3 Leak		
LSPU3-YA-01A	BFP Effluent Pump 3 Fail		
LSPU3-YA-01B	BFP Effluent Pump 3 Estop		
WW1-LALL-01	BFP Wet Well Low Low Level		
WW1-LAH-01	BFP Wet Well High Level		
WW1-LAH-02	BFP Wet Well High Level		
WW1-LAH-03	BFP Wet Well High Level		
WW1-LAHH-01	BFP Wet Well High High Level		

Priority: 1- Plant Shutdown, 2-Process Shutdown, 3-Alarm, 4 Operator Alert
Note: All Alarms are Latching unless otherwise noted.

LIST OF SETPOINTS:

Description	Setpoint	Delay
Level Setpoint Pump No 1 Start		
Level Setpoint Pump No 2 Start		
Level Setpoint Pump No 3 Start		
Low Low Level Cutoff		
High High Level		

EQUIPMENT DESCRIPTION:

The BFP Effluent Lift Station consists of the following major components listed below:

- BFP Effluent Pumps 1-3
    - Constant Speed Pumps

    - Emergency Stop Pushbutton
- Level Transmitter
- Low Level Switch (Low level cutoff)
- High Level Switch
- Valve Vault – To divert flow to the ARF EQ Basin

OPERATIONAL OVERVIEW:

The three BFP effluent pumps are submersible pumps within a wet well that pump filtrate and wash water from the Belt Filter Press building to the ARF EQ basin or bypass it directly to the ATRs or Pond 1 West

LOCAL CONTROL MODE:

Local Control Mode for the BFP Effluent Pumps is available at the MCC located in the electrical room. By selecting HAND at the HOA switch, a pump will start and run continuously until the HOA switch is rotated to the OFF position. Remote control from the PLC is disabled. Hardwired interlocks are still active.

LOCAL SAFETY INTERLOCKS:

The BFP Effluent Pumps shall be immediately called to stop, and an alarm generated if any of the conditions listed below are detected. A physical reset will be required before the pump will be available to operate.

- Motor Overload
- Motor Windings High Temp
- Pump Leak
- E-Stop
- Wetwell Low Low Level

CONTROLLER PROGRAMMED INTERLOCKS:

A BFP Effluent Pump E-stop output shall be triggered, run inhibited and an HMI equipment alarm generated if any of the conditions listed below are detected by SCADA:

- Wet Well Low Level from Transmitter

LOCAL AUTOMATIC CONTROL MODE:

In the event of loss of communication with the plant control system and/or level transmitter failure, the BFP Effluent Pumps will operate based on float level control. Each pump has a dedicated level switch mounted in the wet well at different levels. Refer to electrical control schematics for additional details.

REMOTE MANUAL CONTROL MODE (Plant PLC):

The Plant PLC, CP01 shall manage / coordinate operation of the BFP Effluent Lift Station. Status, alarm and control I/O represented on the referenced P&IDs and as mentioned in this CP shall be accommodated at

the Plant HMI. Owner developed control screens shall include as a minimum the following suite of operator interface screens:

- Login Screen / Main Menu
- Graphic representation of System Overview
- Text-based System Overview including equipment current draw and daily / total runtimes (total runtime reset shall be a supervisory level function), start counts, and well level trends
- Alarm History Screen
- Current Alarm Screen
- Event Log Screen
- Preset Trends Access Screen/Menu
- Help/eO&M (which is to include detailed instruction on how to use the HMI, what information is contained on each major control screen and an outline of the related vendor control narratives)
- Graphic representation of the BFP Effluent Lift Station with access to override manual controls, selection controls and setpoint / timer adjustments. Graphic should include schematic representation of all conveyance system.
- Graphic representation of each pump
- Control/Configuration Palette for the pumps (supervisory level access only)
- Refer to section 17900 for general requirements including:
  - Remote/Manual pump duty rotation (duty/standby)
  - Out-of-Service selection

The BFP Effluent pump station shall provide the following as a minimum:

- Per Pump, on same screen:
  - Status (Run, Hand/Remote, and all Fail Conditions)
  - Manual S/S controls (only accessible if pump station placed in Remote Control Mode)
  - Runtime (daily and lifetime)
  - Start Count (daily, monthly, lifetime)
  - Duty assignment
- Wet well level reading
- Wet well level instrument fault detected
- Wet well LAL (Low Level Cutoff)
- Pump Station A/M status
- BFP Effluent Total Flow
  - Flow rate, Daily Total and net flow meter total display
- Alarms Display
- Process deviation alarm setpoint - display and entry (default = +/-5%)

With the starter exhibiting a Ready status (no faults) at the HMI and the pump station HMI common control station A/M switch in Manual (i.e. Remote Manual Control Mode) the associated pump may be manually controlled by an authorized operator at the HMI using the S/S controls previously

described provided the safety interlock alarms conditions are not detected.

Note: Valid wet well level signal need not be available for Remote Manual start of the pumps.

The PLC logic will process all pump start/stop commands under the supported remote operating modes. Each pump will be set to Remote at the local OI.

The pump remote start will be subject to the following permissives:

- Wet well low-low level (operator adjustable) conditions are not detected.
- The selected pump is ready to operate

A pump shall be called to stop, run inhibited, and a PLANT HMI equipment alarm generated if any of the conditions listed below are detected by the PLC:

- Emergency Stop

REMOTE AUTO CONTROL MODE (Plant PLC):

With the pump station HMI common control station in REMOTE mode, all pump starters exhibiting a Ready status at the HMI will be made available to the PLC REMOTE control logic. (Note: no additional Operator confirmation will be necessary to initiate the pump station.)

Pump station REMOTE start will be subject to the following permissives:

- Valid flow target demand available
- Low level alarm condition not detected
- Level start / stop and timer setpoints populated
- Start sequence populated
- At least one pump is Ready to operate
- Pump station Remote operating mode selected

The control station shall also include a separate Supervisor level control screen to support the following control and monitoring functions:

- Pump Station A/M control selection (a single common A/M control selection shall be used to dictate the control status of all Pumps)
- Pump start sequence select A/M (Pumps shall maintain previous command if transitioning between Auto/Manual.)
- Pump start sequence manual select
    - Note: Pump Remote/Manual rotation logic shall be subject to the requirements of section 17900.

- Tabular representation of:
  - First pump start setpoint with delay timer (entry and display). Default level entry, 10 second delay.
  - Second pump start setpoint with delay timer (entry and display). Default level entry, 10 second delay.
  - Third pump start shall be operator initiated
  - LAL pump station stop setpoint with delay timer (entry and display) Default entries % level TBD, 3 second delay.
  - Wetwell LAHH delay timer (default = 2 seconds)
  - Wetwell LALL override shutdown delay timer (default = 2 seconds)

Pump Station Level Control Logic		
Pump Station Demand Flow	**Demand Falling**	**Demand Rising**
• Longer than 10 seconds • Pump Station in REMOTE Mode • Level is greater than Xft		Start lead pump
• Longer than 10 seconds • 1st pump called to run in REMOTE • 1st cannot meet Level (TBD delay) • Level equal to or greater than 2nd pump start setpoint (TBD)		Start 2nd pump
• Longer than 10 seconds • 2nd pump called to run in REMOTE • Level equal to less than XXft	2nd Pump Stop	
• Longer than 3 seconds • Wet well level equal to or less than pump station stop setpoint (TBD)	Stop all pumps.	
• LALL float switch trip detected	Stop and inhibit start for all pumps until LALL condition clears.	

Appendix CP-02: EQ BASIN AND EQ TRANSFER PUMPS

REFERENCE DOCUMENTS:

Document Number	Document Title	Date
04-I-601	P&ID – ARF EQ Basin	
04-I-602	P&ID – ARF EQ Transfer Pumps	
	Motor Control Schematic	

LIST OF EQUIPMENT AND INSTRUMENTATION:

Equipment Field Tag	Equipment Description
MIXER-03	EQ Basin Mixer
MIX3-TS-01	EQ Basin Mixer Motor Winding High Temp Switch
MIX3-HS-01	EQ Basin Mixer Emergency Stop
FEB1-LSL-01	EQ Basin Wet Well Low Level Switch
FEB1-LIT-01	EQ Basin Wet Well Level Transmitter
FEB1-AIT-01	EQ Basin Wet Well Ammonia Analyzer
LSPUMP-01	EQ Transfer Pump No 1
LSPU1-TS-01	EQ Transfer Pump No 1 Motor Winding High Temp Switch
LSPU1-FCS-01	EQ Transfer Pump No 1 Local Control Station
LSPUMP-02	EQ Transfer Pump No 2
LSPU2-TS-01	EQ Transfer Pump No 2 Motor Winding High Temp Switch
LSPU2-FCS-01	EQ Transfer Pump No 2 Local Control Station
LSPUMP-03	EQ Transfer Pump No 3
LSPU3-TS-01	EQ Transfer Pump No 3 Motor Winding High Temp Switch
LSPU3-FCS-01	EQ Transfer Pump No 3 Local Control Station
LSPI1-PV-01	BFP Discharge plug valve to ARF EQ Basin – normally open
LSPI1-PV-02	Discharge plug valve to Pond 1/SSTP – normally closed
LSPI1-PV-03	Discharge plug valve to Pond 1/SSTP – normally closed
LSPI3-PV-01	ARF Effluent Lift Station Discharge plug valve to Pond 1/SSTP – normally open
FEB1-FIT-01	EQ Transfer Lift Station Flow meter

LIST OF ALARMS

TAG	Description	Priority	Alarm Delay
LSPU1-YA-01A-A	EQ Transfer Pump 1 Fail To Run		
LSPU1-YA-01A-B	EQ Transfer Pump 1 Fail To Stop		
LSPU1-TAH-01	EQ Transfer Pump 1 High Temp		
LSPU1-YA-01A	EQ Transfer Pump 1 VFD Fail		
LSPU1-YA-01B	EQ Transfer Pump 1 Estop		
LSPU2-YA-01A-A	EQ Transfer Pump 2 Fail To Run		
LSPU2-YA-01A-B	EQ Transfer Pump 2 Fail To Stop		
LSPU2-TAH-01	EQ Transfer Pump 2 High Temp		
LSPU2-YA-01A	EQ Transfer Pump 2 VFD Fail		
LSPU2-YA-01B	EQ Transfer Pump 2 Estop		
LSPU3-YA-01A-A	EQ Transfer Pump 3 Fail To Run		
LSPU3-YA-01A-B	EQ Transfer Pump 3 Fail To Stop		
LSPU3-TAH-01	EQ Transfer Pump 3 High Temp		
LSPU3-YA-01A	EQ Transfer Pump 3 VFD Fail		
LSPU3-YA-01B	EQ Transfer Pump 3 Estop		
MIX3-YA-01A-A	EQ Mixer Fail To Run		
MIX3-YA-01A-B	EQ Mixer Fail To Stop		
MIX3-TAH-01	EQ Mixer High Temp		
MIX3-YA-01A	EQ Mixer Fail		
MIX3-YA-01B	EQ Mixer Estop		
FEB1-LAL-01	EQ Basin Low Level		

Priority: 1- Plant Shutdown, 2-Process Shutdown, 3-Alarm, 4 Operator Alert
Note: All Alarms are Latching unless otherwise noted.

LIST OF SETPOINTS:

Description	Setpoint	Delay
Level Setpoint Pump No 1 Start		
Level Setpoint Pump No 2 Start		
Level Setpoint Pump No 3 Start		
Low Level Cutoff - Mixer		
Low Low Level Cutoff - Pump		
High High Level		

EQUIPMENT DESCRIPTION: The EQ Basin and Transfer Pump Station consists of the following major components listed below:

- Equalization Basin Mixer – Constant Speed
- Equalization Transfer Pumps 1-3, Variable Speed
    - Local Control Station
- EQ Basin Level Transmitter
- Low Level Switch (Low level cutoff)

OPERATIONAL OVERVIEW:

The three EQ Transfer pumps deliver process fluid from the Belt Filter presses from the Equalization Basin to the ATR Influent Splitter Box or to the ARF Effluent Channel to drain the EQ Basin.

The process fluid can also bypass the EQ basin and transfer pumps via manual valve, EQ1-PV-02, and be directly fed to the ATR Influent Splitter Box. Normal operation will be with this valve normally closed.

LOCAL CONTROL MODE:

Local Control Mode for the EQ Basin Mixer is available at the MCC located in the electrical room. By selecting HAND at the HOA switch, a pump will start and run continuously until the HOA switch is rotated to the OFF position. Remote control from the PLC is disabled. Hardwired interlocks are still active.

Local control mode will be available at the EQ Transfer equipment VFD. By entering the VFD OI security password and placing the drive in local, the Operator will have access to drive Start/Stop and speed controls. The pump shall run continuously at the set speed once started until called to Stop by the Operator or upon fault detection. The local control mode of operation is not a supported operating mode and should be used for drive or equipment maintenance purposes only.

LOCAL SAFETY INTERLOCKS:

The EQ Mixer shall be immediately called to stop, and an alarm generated if any of the conditions listed below are detected. A physical reset will be required before the pump will be available to operate.

- Motor Overload
- Motor Windings High Temp
- E-Stop

The EQ Transfer Pumps shall be immediately called to stop, and an alarm generated if any of the conditions listed below are detected. A physical reset will be required before the pump will be available to operate.

- VFD Fault
- Motor Windings High Temp
- E-Stop

CONTROLLER PROGRAMMED

INTERLOCKS:

A EQ Mixer and Transfer pump E-stop output shall be triggered, run inhibited and an HMI equipment alarm generated if any of the conditions listed below are detected by SCADA:

- Wet Well Low Level from Transmitter

LOCAL REMOTE CONTROL MODE:

Not applicable.

REMOTE MANUAL CONTROL MODE (Plant PLC):

The Plant PLC shall manage / coordinate operation of the EQ Transfer pump Station. Status, alarm and control I/O represented on the referenced P&IDs and as mentioned in this CP shall be accommodated at the Plant HMI. Owner developed control screens shall include as a minimum the following suite of operator interface screens:

- Login Screen / Main Menu
- Graphic representation of System Overview
- Text-based System Overview including equipment current draw and daily / total runtimes (total runtime reset shall be a supervisory level function), start counts, and well level trends
- Alarm History Screen
- Current Alarm Screen
- Event Log Screen
- Preset Trends Access Screen/Menu
- Help/eO&M (which is to include detailed instruction on how to use the HMI, what information is contained on each major control screen and an outline of the related vendor control narratives)
- Graphic representation of the EQ Transfer Lift Station with access to override manual controls, selection controls and setpoint / timer adjustments. Graphic should include schematic representation of all conveyance system.
- Graphic representation of each pump
- Control/Configuration Palette for the pumps (supervisory level access only)
- Refer to section 17900 for general requirements including:
  - Remote/Manual pump duty rotation (duty/standby)
  - Out-of-Service selection

The overview pump station shall provide the following as a minimum:

- Per Pump, on same screen:
  - Status (Run, Hand/Remote, Speed SP, Speed, and all Fail Conditions)
  - Manual S/S controls (only accessible if pump station placed in Remote Control Mode)
  - Runtime (daily and lifetime)

    - Start Count (daily, monthly, lifetime)
    - Duty assignment
- Wet well level reading
- Wet well level instrument fault detected
- Wet well LAL (Low Level Cutoff)
- Pump Station A/M status
- Alarms Display
- Process deviation alarm setpoint - display and entry (default = +/-5%)

With the starter exhibiting a Ready status (no faults) at the HMI and the mixer station HMI common control station A/M switch in Manual (i.e. Remote Manual Control Mode) the associated mixer may be manually controlled by an authorized operator at the HMI using the S/S controls previously described provided the safety interlock alarms conditions are not detected.

Note: Valid wet well level signal need not be available for Remote Manual start of the pumps.

The PLC logic will process all pump start/stop commands under the supported remote operating modes. Each pump will be set to Remote at the local OI.

The pump remote start will be subject to the following permissives:

- Wet well low-low level (operator adjustable) conditions are not detected.

A transfer pump shall be called to stop, run inhibited, and a PLANT HMI equipment alarm generated if any of the conditions listed below are detected by the PLC:

- Emergency Stop

With the VFD exhibiting a Ready status (no faults) at the HMI and the pump station HMI common control station A/M switch in Manual (i.e. Remote Manual Control Mode) the associated pumps may be manually controlled by an authorized operator at the HMI using the S/S controls previously described provided the safety interlock alarms conditions are not detected.

Note: Valid wet well level signal need not be available for Remote Manual start of the pumps.

The PLC logic will process all pump start/stop commands under the supported remote operating modes. Each pump will be set to Remote at the local OI.

The pump remote start will be subject to the following permissives:

- Wet well low-low level (operator adjustable) conditions are not detected.
- The selected pump is ready to operate

A pump shall be called to stop, run inhibited, and a PLANT HMI equipment alarm generated if any of the conditions listed below are detected by the PLC:
Emergency Stop

REMOTE AUTO CONTROL MODE (Plant PLC):

With the pump station HMI common control station in REMOTE mode, all pump VFDs exhibiting a Ready status at the HMI will be made available to the PLC REMOTE control logic. (Note: no additional Operator confirmation will be necessary to initiate the pump station.)

Pump station REMOTE start will be subject to the following permissives:

- Valid level target available
- Low level alarm condition not detected
- Level start / stop and timer setpoints populated
- Start sequence populated
- At least one pump is Ready to operate
- Pump station Remote operating mode selected

Mixer Remote start will be subject to the following permissives

- Low level alarm condition not detected

The control station shall also include a separate Supervisor level control screen to support the following control and monitoring functions:

- Pump Station A/M control selection (a single common A/M control selection shall be used to dictate the control status of all Pumps)
- Pump start sequence select A/M (Pumps shall maintain previous command if transitioning between Auto/Manual.)
- Pump start sequence manual select
  - Note: Pump Remote/Manual rotation logic shall be subject to the requirements of section 17900.
- Tabular representation of:
  - First pump start setpoint with delay timer (entry and display). Default level entry, 10 second delay.
  - Second pump start setpoint with delay timer (entry and display). Default level entry, 10 second delay.
  - Third pump start shall be operator initiated
  - LAL pump station stop setpoint with delay timer (entry and display) Default entries % level TBD, 3 second delay.

- Wetwell LAHH delay timer (default = 2 seconds)
- Wetwell LALL override shutdown delay timer (default = 2 seconds)

Pump Station Level Control Logic		
Pump Station Demand Flow	**Demand Falling**	**Demand Rising**
• Longer than 10 seconds • Pump Station in REMOTE Mode • Level is greater than Xft		Start lead pump
• Longer than 10 seconds • 1st pump called to run in REMOTE • 1st cannot meet Level (TBD delay) • Level equal to or greater than 2nd pump start setpoint (TBD)		Start 2nd pump
• Longer than 10 seconds • 2nd pump called to run in REMOTE • Level equal to less than XXft	2nd Pump Stop	
• Longer than 3 seconds • Wet well level equal to or less than pump station stop setpoint (TBD)	Stop all pumps.	
• LALL float switch trip detected	Stop and inhibit start for all pumps until LALL condition clears.	

Appendix CP-03: AMMONIA TREATMENT REACTOR AND AERATION BLOWERS

REFERENCE DOCUMENTS:

Document Number	Document Title	Date
04-I-604	P&ID – Ammonia Removal Facility Reactor No 1	
04-I-605	P&ID – Ammonia Removal Facility Reactor No 2	
04-I-606	P&ID – Ammonia Removal Facility Reactors	
05-I-601	ARF Blowers	

LIST OF EQUIPMENT AND INSTRUMENTATION:

Equipment Field Tag	Equipment Description
JBX1-LIT-01	ATR Influent Splitter Box Level Transmitter
JBX1-LIT-02	ATR Influent Splitter Box Level Transmitter
JBX1-MOG-01	ATR Reactor No 1 Weir Gate
JBX1-MOG-02	ATR Reactor No 2 Weir Gate
MIXER-01A	ATR No 1 Mixer No 1
MIX1A-TS-01	ATR No 1 Mixer No 1 Motor Winding High Temp Switch
MIX1A-FCS-01	ATR No 1 Mixer Emergency Stop
MIXER-01B	ATR No 1 Mixer No 2
MIX1B-TS-01	ATR No 1 Mixer No 2 Motor Winding High Temp Switch
MIX1B-FCS-01	ATR No 1 Mixer No 2Emergency Stop
NH3R1-LIT-01	ATR No 1 Wet Well Level Transmitter
NH3R1-AIT-01	ATR No 1 pH/Temp Analyzer
NH3R1-AIT-02	ATR No 1 Dissolved Oxygen Analyzer
NH3R1-AIT-03	ATR No 1 Ammonia Analyzer
CHAN1-LSL-01	ATR No 1 Instrument Chamber Low Level Switch
CHAN1-LSH-01	ATR No 1 Instrument Chamber High Level Switch
CHAN1-LIT-01	ATR No 1 Instrument Chamber Level Transmitter
MIXER-02A	ATR No 2 Mixer No 1
MIX2A-TS-01	ATR No 2 Mixer No 1 Motor Winding High Temp Switch
MIX2A-FCS-01	ATR No 2 Mixer Emergency Stop
MIXER-02B	ATR No 2 Mixer No 2
MIX2B-TS-01	ATR No 2 Mixer No 2 Motor Winding High Temp Switch
MIX2B-FCS-01	ATR No 2 Mixer No 2Emergency Stop
NH3R2-LIT-01	ATR No 1 Wet Well Level Transmitter
NH3R2-AIT-01	ATR No 1 pH/Temp Analyzer
NH3R2-AIT-02	ATR No 1 Dissolved Oxygen Analyzer

BLOWER1	Air Blower No 1
BLWR1-PI-01	Air Blower No 1 suction pressure gauge
BLWR1-PSL-01	Air Blower No 1 suction low pressure switch
BLWR1-TS-01	Air Blower No 1 motor winding high temp switch
BLWR1-TS-02	Air Blower No 1 discharge high temp switch
BLWR1-TI-01	Air Blower No 1 discharge temperature gauge
BLWR1-PI-02	Air Blower No 1 discharge pressure gauge
BLWR1-PSH-01	Air Blower No 1 discharge high pressure switch
BLWR1-FCS-01	Air Blower No 1 field control station
BLOWER2	Air Blower No 2
BLWR2-PI-01	Air Blower No 2 suction pressure gauge
BLWR2-PSL-01	Air Blower No 2 suction low pressure switch
BLWR2-TS-01	Air Blower No 2 motor winding high temp switch
BLWR2-TS-02	Air Blower No 2 discharge high temp switch
BLWR2-TI-01	Air Blower No 2 discharge temperature gauge
BLWR2-PI-02	Air Blower No 2 discharge pressure gauge
BLWR2-PSH-01	Air Blower No 2 discharge high pressure switch
BLWR2-FCS-01	Air Blower No 2 field control station
BLOWER3	Air Blower No 3
BLWR3-PI-01	Air Blower No 3 suction pressure gauge
BLWR3-PSL-01	Air Blower No 3 suction low pressure switch
BLWR3-TS-01	Air Blower No 3 motor winding high temp switch
BLWR3-TS-02	Air Blower No 3 discharge high temp switch
BLWR3-TI-01	Air Blower No 3 discharge temperature gauge
BLWR3-PI-02	Air Blower No 3 discharge pressure gauge
BLWR3-PSH-01	Air Blower No 3 discharge high pressure switch
BLWR3-FCS-01	Air Blower No 3 field control station
NH3R1-MOV-01	Blower discharge flow control valve for reactor No 1
NH3R1-FIT-01	Blower discharge flow meter for reactor No 1
NH3R2-MOV-01	Blower discharge flow control valve for reactor No 2
NH3R2-FIT-01	Blower discharge flow meter for reactor No 2
AIP1-PIT-01	Blowers common header discharge pressure

LIST OF ALARMS

TAG	Description	Priority	Alarm Delay
MIX1A-YA-01A-A	ATR NO 1 MIXER NO 1 FAIL TO START		

MIX1A-YA-01A-B	ATR NO 1 MIXER NO 1 FAIL TO STOP		
MIX1A-TAH-01	ATR NO 1 MIXER NO 1 MOTOR TEMPERATURE HIGH		
MIX1A-YA-01A	ATR NO 1 MIXER NO 1 FAIL		
MIX1A-YA-01B	ATR NO 1 MIXER NO 1 E STOP		
MIX1B-YA-01A-A	ATR NO 1 MIXER NO 2 FAIL TO START		
MIX1B-YA-01A-B	ATR NO 1 MIXER NO 2 FAIL TO STOP		
MIX1B-TAH-01	ATR NO 1 MIXER NO 2 MOTOR TEMPERATURE HIGH		
MIX1B-YA-01A	ATR NO 1 MIXER NO 2 FAIL		
MIX1B-YA-01B	ATR NO 1 MIXER NO 2 E STOP		
JBX1-MOG-NAHH-01	ATR NO 1 INFLUENT SPLITTER BOX MOTORIZED GATE TORQUE HIGH HIGH		
NH3R1-MOV-NAHH-01	ATR NO 1 AERATION MOTORIZED VALVE TORQUE HIGH HIGH		
MIX2A-YA-01A-A	ATR NO 2 MIXER NO 1 FAIL TO START		
MIX2A-YA-01A-B	ATR NO 2 MIXER NO 1 FAIL TO STOP		
MIX2A-TAH-01	ATR NO 2 MIXER NO 1 MOTOR TEMPERATURE HIGH		
MIX2A-YA-01A	ATR NO 2 MIXER NO 1 FAIL		
MIX2A-YA-01B	ATR NO 2 MIXER NO 1 E STOP		
MIX2B-YA-01A-A	ATR NO 2 MIXER NO 2 FAIL TO START		
MIX2B-YA-01A-B	ATR NO 2 MIXER NO 2 FAIL TO STOP		
MIX2B-TAH-01	ATR NO 2 MIXER NO 2 MOTOR TEMPERATURE HIGH		
MIX2B-YA-01A	ATR NO 2 MIXER NO 2 FAIL		
MIX2B-YA-01B	ATR NO 2 MIXER NO 2 E STOP		
JBX1-MOG-NAHH-02	ATR NO 2 INFLUENT SPLITTER BOX MOTORIZED GATE TORQUE HIGH HIGH		
NH3R2-MOV-NAHH-01	ATR NO 2 AERATION MOTORIZED VALVE TORQUE HIGH HIGH		
BLWR1-YA-01A-A	AIR BLOWER NO 1 FAIL TO START		
BLWR1-YA-01A-B	AIR BLOWER NO 1 FAIL TO STOP		
BLWR1-TAH-01A	AIR BLOWER NO 1 MOTOR TEMPERATURE HIGH		
BLWR1-PAL-01	AIR BLOWER NO 1 SUCTION PRESSURE LOW		
BLWR1-PAH-01	AIR BLOWER NO 1 DISCHARGE PRESSURE HIGH		
BLWR1-TAH-01B	AIR BLOWER NO 1 DISCHARGE TEMPERATURE HIGH		
BLWR1-YA-01A	AIR BLOWER NO 1 FAIL		
BLWR1-YA-01B	AIR BLOWER NO 1 E STOP		

BLWR2-YA-01A-A	AIR BLOWER NO 2 FAIL TO START		
BLWR2-YA-01A-B	AIR BLOWER NO 2 FAIL TO STOP		
BLWR2-TAH-01A	AIR BLOWER NO 2 MOTOR TEMPERATURE HIGH		
BLWR2-PAL-01	AIR BLOWER NO 2 SUCTION PRESSURE LOW		
BLWR2-PAH-01	AIR BLOWER NO 2 DISCHARGE PRESSURE HIGH		
BLWR2-TAH-01B	AIR BLOWER NO 2 DISCHARGE TEMPERATURE HIGH		
BLWR2-YA-01A	AIR BLOWER NO 2 FAIL		
BLWR2-YA-01B	AIR BLOWER NO 2 E STOP		
BLWR3-YA-01A-A	AIR BLOWER NO 3 FAIL TO START		
BLWR3-YA-01A-B	AIR BLOWER NO 3 FAIL TO STOP		
BLWR3-TAH-01A	AIR BLOWER NO 3 MOTOR TEMPERATURE HIGH		
BLWR3-PAL-01	AIR BLOWER NO 3 SUCTION PRESSURE LOW		
BLWR3-PAH-01	AIR BLOWER NO 3 DISCHARGE PRESSURE HIGH		
BLWR3-TAH-01B	AIR BLOWER NO 3 DISCHARGE TEMPERATURE HIGH		
BLWR3-YA-01A	AIR BLOWER NO 3 FAIL		
BLWR3-YA-01B	AIR BLOWER NO 3 E STOP		

Priority: 1- Plant Shutdown, 2-Process Shutdown, 3-Alarm, 4 Operator Alert
Note: All Alarms are Latching unless otherwise noted.

LIST OF SETPOINTS:

Description	Setpoint	Delay

Ammonia Treatment Reactor

EQUIPMENT DESCRIPTION:

The Ammonia Treatment Reactors consists of the following major components listed below per train, total of 2 trains:

- Two Variable Speed Mixers
  - Local Control Station
- Influent Weir Gate

- Influent Level Transmitter
- Ammonia Analyzer
- Instrument chamber instrumentation
  - Level Transmitter
  - High- and Low-Level Switches
  - DO, pH/temp analyzers

OPERATIONAL OVERVIEW:

Belt Filter Press process fluid is transferred into the ATR splitter box where flow is split between the two reactors.

The flow for each reactor is managed by a weir gate and associated level transmitter.

LOCAL CONTROL MODE:

Local control mode will be available at the Mixer VFD. By entering the VFD OI security password and placing the drive in local, the Operator will have access to drive Start/Stop and speed controls. The pump shall run continuously at the set speed once started until called to Stop by the Operator or upon fault detection. The local control mode of operation is not a supported operating mode and should be used for drive or equipment maintenance purposes only.

With the gate actuator LOR switch in Local, the gate weir may be manually positioned at the actuator by means of the Open-Stop-Close selector switch and position selector. Selecting Open will drive the valve open. Selecting Close will drive the valve closed. Selecting Close while the valve is opening will stop the valve opening movement and then drive the valve closed (and vice versa). Selecting Stop will hold the valve at the current position. Local operation of the actuator is intended to be reserved for field testing activities only.

LOCAL SAFETY INTERLOCKS:

The ATR Mixer shall be immediately called to stop, and an alarm generated if any of the conditions listed below are detected. A physical reset will be required before the pump will be available to operate.

- VFD Fault
- Motor Windings High Temp
- E-Stop

A gate actuator shall be called to stop and a local alarm generated (and subsequently reported to the PLC) if any of the conditions listed below are detected. A physical reset will be required at the actuator (per the manufacturer's reset procedure) before the valve actuator will be available to operate.

- Motor Overload
- High Torque

With loss of control signal, the gate actuator will be configured to fail closed. With loss of line power, the actuator will be automatically

switched to battery power thereby allowing the actuator to process a remote command signal.

CONTROLLER PROGRAMMED INTERLOCKS:

A Mixer E-stop output shall be triggered, run inhibited and an HMI equipment alarm generated if any of the conditions listed below are detected by SCADA:

- Reactor Low Level from Transmitter

LOCAL REMOTE CONTROL MODE:

Not applicable.

REMOTE MANUAL CONTROL MODE (Plant PLC):

The Plant PLC shall manage / coordinate operation of the Ammonia Treatment Reactor. Status, alarm and control I/O represented on the referenced P&IDs and as mentioned in this CP shall be accommodated at the Plant HMI. Owner developed control screens shall include as a minimum the following suite of operator interface screens:

- Login Screen / Main Menu
- Graphic representation of System Overview
- Text-based System Overview including equipment current draw and daily / total runtimes (total runtime reset shall be a supervisory level function), start counts, and well level trends
- Alarm History Screen
- Current Alarm Screen
- Event Log Screen
- Preset Trends Access Screen/Menu
- Help/eO&M (which is to include detailed instruction on how to use the HMI, what information is contained on each major control screen and an outline of the related vendor control narratives)
- Graphic representation of the reactors with access to override manual controls, selection controls and setpoint / timer adjustments. Graphic should include schematic representation of all conveyance system.
- Graphic representation of each mixer/reactor
- Control/Configuration Palette for the mixers and blowers (supervisory level access only)
- Refer to section 17900 for general requirements including:
  - Remote/Manual pump duty rotation (duty/standby)
  - Out-of-Service selection

The overview pump station shall provide the following as a minimum:

- Per Mixer, on same screen:

    - Status (Run, Hand/Remote, Speed SP, Speed, and all Fail Conditions)
    - Manual S/S controls (only accessible if pump station placed in Remote Control Mode)
    - Runtime (daily and lifetime)
    - Start Count (daily, monthly, lifetime)
    - Duty assignment
- Reactor level reading
- Reactor level instrument fault detected
- Reactor LAL (Low Level Cutoff)
- Reactor A/M status
- Alarms Display
- Process deviation alarm setpoint - display and entry (default = +/-5%)

With the VFD exhibiting a Ready status (no faults) at the HMI and the pump station HMI common control station A/M switch in Manual (i.e. Remote Manual Control Mode) the associated pumps may be manually controlled by an authorized operator at the HMI using the S/S controls previously described provided the safety interlock alarms conditions are not detected.

Note: Valid level signal need not be available for Remote Manual start of the pumps.

The PLC logic will process all pump start/stop commands under the supported remote operating modes. Each pump will be set to Remote at the local OI.

The mixer remote start will be subject to the following permissives:

- Reactor low-low level (operator adjustable) conditions are not detected.

A mixer shall be called to stop, run inhibited, and a PLANT HMI equipment alarm generated if any of the conditions listed below are detected by the PLC:
Emergency Stop

REMOTE AUTO CONTROL MODE (Plant PLC):

With the reactor HMI common control station in REMOTE mode, all pump VFDs exhibiting a Ready status at the HMI will be made available to the PLC REMOTE control logic. (Note: no additional Operator confirmation will be necessary to initiate the pump station.)

Pump station REMOTE start will be subject to the following permissives:

- Valid level target available

- Low level alarm condition not detected
- Level start / stop and timer setpoints populated

Mixer Remote start will be subject to the following permissives

- Low level alarm condition not detected

ARF AERATION BLOWERS

EQUIPMENT DESCRIPTION:

The ARF Blower System shall consist of the major components listed below:

- Vendor skid equipment:
  - Three VFD positive displacement blowers arranged on a common discharge header and designed to operate in a 2 plus 1 arrangement to support the operation of the air lift pumps and ammonia treatment reactors no 1 and 2.
  - Each Blower Enclosure includes the following instrumentation
    - Suction and Discharge pressure gauges
    - Suction and Discharge pressure switches
    - Motor temperature high switch
    - Discharge high temperature switch
    - Discharge temperature gauge
    - Suction and discharge silencers
- Vendor equipment shipped loose:
  - Common discharge header pressure transmitter
  - Reactor 1 Discharge thermal mass flow meter
  - Reactor 1 Discharge flow control valve
  - Reactor 2 Discharge thermal mass flow meter
  - Reactor 2 Discharge flow control valve

- Contractor furnished equipment:
  - Lockable manual butterfly valve (located on section 1 process air header)
  - Air diffuser branches with manual isolation butterfly valve
  - Common Discharge Header Temperature Gauge

Each blower will be furnished as a pre-assembled skid for Contractor installation and will include an intake low suction pressure switch, inlet and outlet silencer, discharge safety valve, discharge high temperature and discharge high pressure switch as shown on the referenced P&IDs. All switches shall be supplied as dual-setpoint type. The common header discharge pressure transmitter will be used for monitoring only. Discharge diffusers installed within each chamber's collection sump will be equipped with manual isolation valves only.

Variable speed motors will be driven by Contractor furnished VFDs housed in the electrical room. The VFDs will be configured by the VFD Supplier to communicate with the Plant PLC (for

monitoring and control) using hardwired signals as shown on the referenced Network Block Diagram and detailed in section 17900.

OPERATIONAL OVERVIEW:

With detection of ARF system online, process flows are gravity fed are pumped to the ARF splitter box where the process is split between two trains and then aerated to support DO levels 0-Xmg/L.

The basin is aerated by the blowers to maintain a fixed dissolved oxygen level. Specifically, air flow to the basin is controlled by the blower's VFD which works to maintain an operator established dissolved oxygen level within the tank based on a PID developed flow rate. The flow rate to the tank is measured by a thermal mass air flow meter and the readings are propagated to the Plant PLC controller as control feedback - all as detailed in the sections below.

LOCAL CONTROL MODE:

Local control mode will be available at the blower VFD. By entering the VFD OI security password and placing the drive in local, the Operator will have access to drive Start/Stop and speed controls. The blower shall run continuously once started until called to Stop by the Operator or upon fault detection. The local control mode of operation is not a supported operating mode and should be used for drive or blower maintenance purposes only.

LOCAL SAFETY INTERLOCKS:

An blower shall be immediately called to stop and an alarm generated if any of the conditions listed below are detected. A physical reset will be required at the drive before the blower will be available to operate. Refer to section 17900-2.2-O for LCS E-stop control.

- Drive Fault
- Motor Overload or High Current
- Motor Winding High Temperature
- Low Intake Pressure
- High Discharge Pressure
- High Discharge Temperature
- Blower Surge (low current)

CONTROLLER PROGRAMMED SAFETY INTERLOCKS:

Not applicable.

LOCAL AUTO CONTROL MODE:

Not applicable.

REMOTE MANUAL CONTROL MODE

(Plant PLC):

The Plant PLC shall monitor equipment status and alarms as shown on the referenced P&ID drawings. An overview control station shall be developed for the Process Blower System at the HMI. The overview station shall provide the following as a minimum:

- Per Blower:
  - Status (Auto/Manual, Run, Ready, Speed Feedback, Current Draw, E-stop and all Fail Conditions)
  - Duty selection
- Blower system common discharge pressure and alarm (PAH and PAHH)
- Common discharge Instantaneous process air flow
- Tank DO reading and alarms (AAH, AAL and AALL)
- Plant Status (Run / Off, Auto / Manual) and Operating Mode

The overview station shall include separate pop-up Supervisor-level control palettes to support Blower System Control functions:

- Blower start sequence Auto/Manual
  - **Note:** Blower Auto/Manual rotation logic shall be subject to the requirements of section 17900-2.2.
- Manual start sequence select (with display of current start sequence)
- Auto Mode Select:
  - Fixed Flow Control Mode
    - Flow setpoint range - display and entry
    - Flow setpoint – display and entry (default = TBD)
    - Start/stop transition timers and PID limits - display and entry (see control logic table for default values)
  - DO Trim Control Mode
    - DO setpoint range - display and entry
    - DO Setpoint – display and entry (default = TBD)
    - Start/stop transition timers and PID limits - display and entry (see control logic table for default values)
- Flow deadband - display and entry (default = TBD)
- DO deadband - display and entry (default = TBD)
- Process deviation alarm setpoint - display and entry (default = +/-5%)
- Tank setpoints:
  - Blower override shutdown level setpoint (default = TBC) and time delay (2sec) - display and entry
  - Blower start level setpoint (default = TBC) and time delay (10sec) - display and entry

Based on a standard drive control faceplate, the overview station shall include a separate pop-up Operator-level control palette for each blower to support the following monitoring and control functions:

- Status (Run, Ready, Speed Feedback, Current Draw, E-stop and all Fail Conditions)
- Remote Auto/Manual mode select (independent of Plant Auto/Manual operating status)
- Start / Stop control and Speed Setpoint - only available in Remote Manual mode with blower Ready status confirmation
    - With Operator start, a blower shall run continuously at the Operator set speed until called to stop or a fault condition is encountered.
    - Should the Tank level fall below the preset blower shutdown level for longer than the preset time delay, the blower will be immediately called to stop and start inhibited. With tank level recovery above the blower start level setpoint for longer than the preset time delay, the blower PLC lockout will be auto reset thereby allowing a Ready status to be restored and re-start permitted.
- Runtime (daily and lifetime)
- Link to Blower System common PID controller (refer to CP-XX)

REMOTE AUTO CONTROL MODE

With a blower's READY status confirmed, the Plant PLC shall operate the available blowers in Duty/Standby fashion to meet system DO setpoint. With the start of the duty blower, the blower speed will ramp up based on a demand cascade control signal (refer to control mode descriptions below) to maintain a discharge flow rate as directly referenced from the monitored current draw (Plant PLC):

- DO Control Loop: DO sensor shall be installed in the aeration basin. An authorized Operator shall enter a DO setpoint at the SCADA HMI. The setpoint shall be used in a PID control loop (with preset deadband) to generate a flow setpoint based on the Operator selected active DO signal. In addition, a flow demand signal, based on the PID loop result, shall be used in the PLC's demand calculation logic to determine the required blower system discharge flow setpoint.
    - DO Setpoint Range: 0 – 2mg/l

The blower control system shall issue an alarm if unable to maintain ±5% of the flow setpoint for greater than 60 seconds.

With detection of Operator initiated Plant Auto Start, all blowers exhibiting a Ready status shall be made available to the Blower auto start sequence. The Plant PLC PID controller (refer to CS-XX for implementation requirements) shall operate the blowers adjust the common speed output based on the Operator selected control mode, control setpoints and timers. Prior to Blower System Auto Start an authorized Operator will be required to establish the following control parameters:

- At least one blower skid has been selected for duty and exhibits a Ready status. Blower duty selection options are as follows:
    - Duty – lead start position
    - Standby – available to start in the event the duty blower becomes unavailable and a blower is being called to start
    - Offline – not available to start

- Blower System Remote Auto Control mode has been selected:
    - DO Control Mode
        - **Note 1:** Drive ramp rate, min speed and max speed shall be as set at the VFD. The PID controls shall take into account the drive settings per section 17900-2.2.

With duty blower start, the Plant PLC will ramp the blower speed as necessary to achieve the flow setpoint.

The Plant PLC control logic will employ a Supervisor adjustable operating deadband of +/-5% of maximum. PLC ramp of the PID output will be suspended if the PV is within the preset operating deadband. PV deviation outside of the deadband limits for longer than 2 seconds will release the PID deadband suspension.

As system demand decreases (through Operator adjustment of setpoint or achievement of desired water quality), the Plant PLC shall adjust the blower speed as necessary to maintain the PV within the setpoint deadband.

If a blower fails, fails to start or stop, or becomes otherwise unavailable (i.e. Not Ready) the condition shall be alarm registered at the Plant HMI and the next blower in sequence shall be immediately called to start or stop (thereby bypassing the preset timers). This shall not impact the selected start sequence.

Note 1: All PV setpoints, PID threshold setpoints and timers shall be adjustable at the Plant HMI Supervisory level.

Appendix CP-04: ARF EFFLUENT PUMP STATION

REFERENCE DOCUMENTS:

Document Number	Document Title	Date
04-I-607	P&ID – ARF Effluent Pump Station	
	Motor Control Schematic	

LIST OF EQUIPMENT AND INSTRUMENTATION:

Equipment Field Tag	Equipment Description
LSPUMP-04	ARF Effluent Pump No 1
LSPU4-TS-01	ARF Effluent Pump No 1 Motor Winding High Temp Switch
LSPU4-HS-01	ARF Effluent Pump No 1 Emergency Stop
LSPU4-PI-01	ARF Effluent Pump No 1 Suction Pressure Gauge
LSPU4-PI-02	ARF Effluent Pump No 1 Discharge Pressure Gauge
LSPUMP-05	ARF Effluent Pump No 2
LSPU5-TS-01	ARF Effluent Pump No 2 Motor Winding High Temp Switch
LSPU5-HS-01	ARF Effluent Pump No 2 Emergency Stop
LSPU5-PI-01	ARF Effluent Pump No 2 Suction Pressure Gauge
LSPU5-PI-01	ARF Effluent Pump No 2 Discharge Pressure Gauge
LSPUMP-06	ARF Effluent Pump No 3
LSPU6-TS-01	ARF Effluent Pump No 3 Motor Winding High Temp Switch
LSPU6-HS-01	ARF Effluent Pump No 3 Emergency Stop
LSPU6-PI-01	ARF Effluent Pump No 3 Suction Pressure Gauge
LSPU6-PI-01	ARF Effluent Pump No 3 Discharge Pressure Gauge
CHAN1-LSL-01	ATR No 1 Instrument Chamber Low Level Switch
CHAN1-LSH-01	ATR No 1 Instrument Chamber High Level Switch
CHAN1-LIT-01	ATR No 1 Instrument Chamber Level Transmitter

LIST OF ALARMS

TAG	Description	Priority	Alarm Delay
LSPU4-YA-01A-A	ARF Effluent Pump 1 Fail To Run		
LSPU4-YA-01A-B	ARF Effluent Pump 1 Fail To Stop		
LSPU4-TAH-01	ARF Effluent Pump 1 High Temp		
LSPU4-YA-01A	ARF Effluent Pump 1 Fail		
LSPU4-YA-01B	ARF Effluent Pump 1 Estop		
LSPU5-YA-01A-A	ARF Effluent Pump 2 Fail To Run		
LSPU5-YA-01A-B	ARF Effluent Pump 2 Fail To Stop		
LSPU5-TAH-01	ARF Effluent Pump 2 High Temp		
LSPU5-YA-01A	ARF Effluent Pump 2 Fail		
LSPU5-YA-01B	ARF Effluent Pump 2 Estop		

LSPU6-YA-01A-A	ARF Effluent Pump 3 Fail To Run		
LSPU6-YA-01A-B	ARF Effluent Pump 3 Fail To Stop		
LSPU6-TAH-01	ARF Effluent Pump 3 High Temp		
LSPU6-YA-01A	ARF Effluent Pump 3 Fail		
LSPU6-YA-01B	ARF Effluent Pump 3 Estop		
CHAN1-LAL-01	ATR No 1 Instrument Chamber Low Level		
CHAN1-LAH-01	ATR No 1 Instrument Chamber High Level		

Priority: 1- Plant Shutdown, 2-Process Shutdown, 3-Alarm, 4 Operator Alert
Note: All Alarms are Latching unless otherwise noted.

LIST OF SETPOINTS:

Description	Setpoint	Delay
Level Setpoint Pump No 1 Start		
Level Setpoint Pump No 2 Start		
Level Setpoint Pump No 3 Start		
Low Low Level Cutoff		
High High Level		

EQUIPMENT DESCRIPTION:

The ARF Effluent Pump Station consists of the following major components listed below:

- ARF Effluent Pumps 1-3
  - Constant Speed Pumps
  - Emergency Stop Pushbutton
- ARF Effluent Channel Level Transmitter
- ARF Effluent Channe Low Level Switch (Low level cutoff)
- ARF Effluent Channe High Level Switch

OPERATIONAL OVERVIEW:

The three ARF effluent pumps transfers the treated process fluid from the ARF system to the bypass valve vault connected to Pond 1W and SSTP.

LOCAL CONTROL MODE:

Local Control Mode for the ARF Effluent Pumps is available at the MCC located in the electrical room. By selecting HAND at the HOA switch, a pump will start and run continuously until the HOA switch is rotated to the OFF position. Remote control from the PLC is disabled. Hardwired interlocks are still active.

LOCAL SAFETY INTERLOCKS:

The ARF Effluent Pumps shall be immediately called to stop, and an alarm generated if any of the conditions listed below are detected. A physical reset will be required before the pump will be available to operate.

- Motor Overload

- Motor Windings High Temp
- E-Stop

CONTROLLER PROGRAMMED INTERLOCKS:

An ARF Effluent Pump E-stop output shall be triggered, run inhibited and an HMI equipment alarm generated if any of the conditions listed below are detected by SCADA:

- Wet Well Low Level from Transmitter

LOCAL REMOTE CONTROL MODE:

Not applicable.

REMOTE MANUAL CONTROL MODE (Plant PLC):

The Plant PLC shall manage / coordinate operation of the ARF Effluent Pump Station. Status, alarm and control I/O represented on the referenced P&IDs and as mentioned in this CP shall be accommodated at the Plant HMI. Owner developed control screens shall include as a minimum the following suite of operator interface screens:

- Login Screen / Main Menu
- Graphic representation of System Overview
- Text-based System Overview including equipment current draw and daily / total runtimes (total runtime reset shall be a supervisory level function), start counts, and well level trends
- Alarm History Screen
- Current Alarm Screen
- Event Log Screen
- Preset Trends Access Screen/Menu
- Help/eO&M (which is to include detailed instruction on how to use the HMI, what information is contained on each major control screen and an outline of the related vendor control narratives)
- Graphic representation of the ARF Effluent Pump Station with access to override manual controls, selection controls and setpoint / timer adjustments. Graphic should include schematic representation of all conveyance system.
- Graphic representation of each pump
- Control/Configuration Palette for the pumps (supervisory level access only)
- Refer to section 17900 for general requirements including:
  - Remote/Manual pump duty rotation (duty/standby)
  - Out-of-Service selection

The ARF effluent pump station overview shall provide the following as a minimum:

- Per Pump, on same screen:
  - Status (Run, Hand/Remote, and all Fail Conditions)
  - Manual S/S controls (only accessible if pump station placed in Remote Control Mode)
  - Runtime (daily and lifetime)
  - Start Count (daily, monthly, lifetime)
  - Duty assignment
- Effluent Channel level reading
- Effluent Channel level instrument fault detected
- Effluent Channel LAL (Low Level Cutoff)
- Pump Station A/M status
- Alarms Display
- Process deviation alarm setpoint - display and entry (default = +/-5%)

With the starter exhibiting a Ready status (no faults) at the HMI and the pump station HMI common control station A/M switch in Manual (i.e. Remote Manual Control Mode) the associated pump may be manually controlled by an authorized operator at the HMI using the S/S controls previously described provided the safety interlock alarms conditions are not detected.

Note: Valid Effluent Channel level signal need not be available for Remote Manual start of the pumps.

The PLC logic will process all pump start/stop commands under the supported remote operating modes. Each pump will be set to Remote at the local OI.

The pump remote start will be subject to the following permissives:

- Wet well low-low level (operator adjustable) conditions are not detected.
- The selected pump is ready to operate

A pump shall be called to stop, run inhibited, and a PLANT HMI equipment alarm generated if any of the conditions listed below are detected by the PLC:

- Emergency Stop

REMOTE AUTO CONTROL MODE (Plant PLC):

With the pump station HMI common control station in REMOTE mode, all pump starters exhibiting a Ready status at the HMI will be made available to the PLC REMOTE control logic. (Note: no additional Operator confirmation will be necessary to initiate the pump station.)

Pump station REMOTE start will be subject to the following permissives:

- Valid level target demand available
- Low level alarm condition not detected
- Level start / stop and timer setpoints populated
- Start sequence populated
- At least one pump is Ready to operate
- Pump station Remote operating mode selected

The control station shall also include a separate Supervisor level control screen to support the following control and monitoring functions:

- Pump Station A/M control selection (a single common A/M control selection shall be used to dictate the control status of all Pumps)
- Pump start sequence select A/M (Pumps shall maintain previous command if transitioning between Auto/Manual.)
- Pump start sequence manual select
  - Note: Pump Remote/Manual rotation logic shall be subject to the requirements of section 17900.
- Tabular representation of:
  - First pump start setpoint with delay timer (entry and display). Default level entry, 10 second delay.
  - Second pump start setpoint with delay timer (entry and display). Default level entry, 10 second delay.
  - Third pump start shall be operator initiated
  - LAL pump station stop setpoint with delay timer (entry and display) Default entries % level TBD, 3 second delay.
  - Effluent Channel LAHH delay timer (default = 2 seconds)
  - Effluent Channel LALL override shutdown delay timer (default = 2 seconds)

Pump Station Level Control Logic		
Pump Station Demand Level	**Demand Falling**	**Demand Rising**
• Longer than 10 seconds • Pump Station in REMOTE Mode • Level is greater than Xft		Start lead pump
• Longer than 10 seconds • 1st pump called to run in REMOTE • 1st cannot meet Level (TBD delay) • Level equal to or greater than 2nd pump start setpoint (TBD)		Start 2nd pump

• Longer than 10 seconds • 2nd pump called to run in REMOTE • Level equal to less than XXft	2nd Pump Stop	
• Longer than 3 seconds • Wet well level equal to or less than pump station stop setpoint (TBD)	Stop all pumps.	
• LALL float switch trip detected	Stop and inhibit start for all pumps until LALL condition clears.	

Appendix CP-05: PID CONTROL - GENERAL

REFERENCE DOCUMENTS:

This appendix section is applicable as a general requirement reference for all 17900 appendices with a PID development requirement.

EQUIPMENT DESCRIPTION:

Not Applicable.

OPERATIONAL OVERVIEW:

Proportional Integral Derivative (PID) controllers shall be programmed at the Plant PLC (or VCP PLC) to control flow rates, pressures, temperature, chemical feed rates and other processes. Each PID controller shall be provided with a graphical control station at the Plant HMI (and/or VCP OIT) with status monitoring and controls as detailed below. Loops shall be initially tuned using emulation tools configured to simulate field conditions as described herein in preparation for witnessed factory testing and later fine tuning during system field commissioning.

LOCAL CONTROL MODE:

The PID controller output shall continue to track a pump's speed / stroke rate or a valve's position even when the pump or the valve is outside Plant PLC / VCP PLC control (i.e., Local Control Mode).

PLANT PLC / VCP PLC; PLANT HMI / VCP OIT:

A standard template PID controller faceplate shall be developed for use at the Plant HMI (and/or VCP PLC OIT). The template is intended to serve as a Administrator accessible (but Operator viewable) PID graphical control station and shall include the following features as a minimum:

- Auto/Manual PID control selection (In manual mode, adjustment of the PID output will be supported.)
- Direct acting (increasing PV results in increasing output) and reverse acting (increasing PV results in decreasing output) selection
- Control deviation Enable / Disable
- Separate tuning parameters for the proportional controller, integral controller, and derivative controller.
- Maximum and minimum limits on the CV output as applicable.
- Output tracking.
- Separate PID controllers for compound loops: one controller for the feed-forward control, and one controller for the feed-back control.
- Tieback with bumpless transfers between auto, manual and local.
- Deadband to freeze the controller output in response to a small error and PID re-engagement time delay setting should error exceed the deadband limits

    - Note: specific handling of deadband control shall be as per individual control philosophy sections.
- Anti-reset-windup to limit the integral controller output from becoming too large when the output is clamped.
- In the automatic mode the output of the PID controller shall be slew rate limited to limit the maximum rate of change of the output
- Expandable 5-min live trend display of PV and CV values

In support of the above features, the PID control station shall:

- Display and provide a means to adjust the process setpoint or feed ratio. The PLC shall limit the range of the setpoint to a safe value.
- Display the process variables (PV), output (CV), and actual device response, such as pump speed or valve position.
- For compound loops:
    - Display that portion of the control signal that is due to feed-back or trim, and that portion that is due to feed-forward or pacing.
    - Display both the feedback process signal such as pH, and the feed-forward signal such as flow stream.
    - Provide an operator adjustable limit to the feed-back control signal that is independent of the feed-forward signal.
- Where applicable display the actual flow, calculated flow and/or production ratio.
- Display a flag when the controller output is clamped, limited, or forced

PID setpoint entries shall be made accessible to Administrator level users only.

Process variable dampening through use of running averages shall be subject to the requirements of section 17900-2.2.

Appendix CP-06: MISCELLANEOUS SYSTEMS

UPS UNITS:

The project shall include a centralized smart UPS unit with battery monitoring system, both of which shall be equipped with a MB/RTU communication card configured to share the following alarm and status data:

- UPS Unit:
  - UPS: OK / Fault
  - UPS Input Power: Online / Offline
  - UPS Bypass: Engaged / Disengaged
  - UPS Power: Online / Offline
  - UPS Battery Status: Ok / Depleted
  - UPS Battery Voltage: Ok / Low
  - UPS Charger Temperature: OK / High
  - UPS Fan Status: OK / Fault
- Battery Monitoring Unit
  - Per Battery Module:
    - Impedance
    - Temperature
    - Voltage

PANEL STATUS:

The access door(s) of each field control panel and RIO panel are to include intrusion switches, normally closed and wired in series where multiple switches are employed. In addition, each control and RIO cabinet will include a temperature monitoring switch wired directly to the panel I/O for alarm monitoring. Required I/O tags shall be as defined in the latest revision of the project I/O Schedule.

The System Integrator shall be required to develop a control network overview control screen as detailed in specification section 17900-2.02. Access to a pop-up status palette for each panel shall be made available. Status data shall include (as applicable to panel content):

- Panel intrusion status
- Temperature alarms
- Primary power supply fail (PLC, RIO, and panel)
- Secondary power supply fail (PLC, RIO, and panel)
- Primary controller fault
- Secondary controller fault

ANALYZERS:

A separate analyzer summary screen shall be developed at the Plant HMI. The summary screen shall be accessible from the main menu. The summary screen shall include all analyzers detailed in the contract drawings, grouped by area and with train data tabularized for easy comparison.

For each analyzer, the Plant PLC shall be configured to monitor the following points:

- Analyzer reading

- Analyzer alarms
- Transmitter / Sensor fault
- Sample low flow alarm

Note: analyzer objects (capable of displaying current reading and conveying alarm and fault conditions) shall also be displayed on all associated process screens.