PROJECT MANUAL

Volume 2

Replace Boilers and Controls

Farmington Correction Center

Farmington, Missouri

Designed By: Rogers-Schmidt Engineering Co., P.C.
1736 West Park Center Dr., Suite 204
St. Louis, MO 63026

Date Issued: April 26, 2023

Project No.: C2006-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION

Facilities Management, Design & Construction

SECTION 000107A - PROFESSIONAL SEALS AND CERTIFICATIONS – MECHANICAL & STRUCTURAL

PROJECT NUMBER: C2006-01

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

Certifications of Responsibility
The design professional whose personal seal and signature appear hereon, assumes responsibility only for what appears on the documents listed below and disclaims, pursuant to Missouri Code of State Regulations CSR 2030-3.060, any responsibility for any and all other plans, specifications, estimates, reports or other documents or instruments not sealed by the undersigned design professional relating to, or intended to be used for any part or parts of the project to which this refers.

Drawings:

G, SD, S, MD, M, and MP Series

Specifications:

Divisions 1 to 23

Expires 12/31/23
Christopher L. Barth, P.E.

END OF SECTION 000107A

SECTION 000107B - PROFESSIONAL SEALS AND CERTIFICATIONS - ELECTRICAL

PROJECT NUMBER: C2006-01

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Drawings:

ED and E Series

Specifications:

Divisions 26

Expires 12/31/24
Barry D. Freiner, P.E.

END OF SECTION 000107B

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DIVISION 26 – ELECTRICAL

SECTION 000115 – LIST OF DRAWINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 01 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section provides a comprehensive list of the drawings that comprise the Bid Documents for this project.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 LIST OF DRAWINGS

A. The following list of drawings is a part of the Bid Documents:

	TITLE	SHEET #	DATE
1.	Title Sheet	Sheet G-001	04-26-23
2.	Site Maps and Drawing Index	Sheet G-002	04-26-23
3.	Construction Limits, Schedule & Phasing	Sheet G-003	04-26-23
4.	Structural Demolition Plan – Power Plant - H2O Treatment	Sheet SD-401	04-26-23
5.	Structural Demolition Plan – Power Plant - Basement	Sheet SD-402	04-26-23
6.	Structural Plan – Power Plant – H20 Treatment	Sheet S-401	04-26-23
7.	Structural Sections & Details	Sheet S-402	04-26-23
8.	Mechanical Demolition Plan - Power Plant	Sheet MD-401	04-26-23
9.	Flow Diagram – Demolition – H2O Treatment	Sheet MD-601	04-26-23
10.	Mechanical Plan – Power Plant – H2O Treatment	Sheet M-401	04-26-23
11.	Mechanical – Details	Sheet M-501	04-26-23
12.	Mechanical – Symbols & Schedules	Sheet M-600	04-26-23
13.	Flow Diagram – H2O Treatment	Sheet M-601	04-26-23
14.	Flow Diagram – RO Water System	Sheet M-602	04-26-23
15.	Mechanical Piping Plan – Power Plant – Low	Sheet MP-401	04-26-23
16.	Mechanical Piping Plan – Power Plant – High	Sheet MP-402	04-26-23
17.	Mechanical Piping Plans – Power Plant – East	Sheet MP-403	04-26-23
18.	Plumbing Plan – Power Plant – H2O Treatment	Sheet P-401	04-26-23
19.	Electrical Symbols, Abbreviations & General Notes	Sheet E-001	04-26-23
20.	Electrical Demolition Plan – Power Plant	Sheet ED-401	04-26-23

TITLE	SHEET #	DATE
21. Electrical Plan – Power Plant	Sheet E-401	04-26-23
22. Schedules, Details and Elevations	Sheet E-501	04-26-23
23. One-Line Diagram – North	Sheet E-601	04-26-23
24. Motor Wiring Schematic	Sheet E-602	04-26-23

END OF SECTION 000115

SECTION 011000 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Volume 2 Project consists of repairs and retrofits to the Power Plant's make-up water and pumped condensate systems and the installation of a new reverse osmosis water treatment system.

1. Project Location: 1012 West Columbia Street, Farmington, Missouri 63640.

2. Owner: State of Missouri, Office of Administration, Division of Facilities Management, Design and Construction, Harry S Truman State Office Building, Post Office Box 809, 301 West High Street, Jefferson City, Missouri 65102.

B. Contract Documents, dated April 26, 2023 were prepared for the Project by Rogers-Schmidt Engineering Co., P.C., 1736 West Park Center Drive, Suite 204, Saint Louis, Missouri 63026.

C. The Work consists of repairs and retrofits to the Power Plant's make-up water and pumped condensate systems and the installation of a new reverse osmosis water treatment system to improve the Power Plant's boiler make-up water quality**.**

1. The Work includes, but is not limited to, the demolition of steam engine generators, replacement of existing pumped condensate and make-up water piping systems, the installation of a new reverse water treatment system, RO water storage tank, RO water feed pumps, and associated structural, plumbing, piping, insulation, power, control, and instrumentation systems.

D. The Work will be constructed under a single prime contract.

1.3 WORK SEQUENCE

A. The Work will be conducted in phases, as required to provide uninterrupted operation of the facility, except for approved outages.

B. The sequencing, phasing and scheduling of all work shall be dependent on and subject to facility operations.

1.4 CONTRACTOR USE OF PREMISES

A. General: During the construction period the Contractor shall have limited use of the premises for construction operations, including limited use of the site.

B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.

1. Owner Occupancy: Allow for Owner occupancy and use by the public.

2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage cause by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.5 OCCUPANCY REQUIREMENTS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate owner usage. Perform the Work so as not to interfere with the Owner's operations.

1.6 MISCELLANEOUS PROVISIONS

A. The State of Missouri has an existing contract with Walter Louis Fluid Technologies for water treatment services.

1. The State of Missouri will utilize this existing contract to provide all chemicals needed for cleaning, flushing, and startup as well as all future chemicals needed to protect and maintain the equipment and piping systems.

2. The Contractor shall coordinate with Walter Louis Fluid Technologies to ensure the facility's chemical treatment systems are compatible with and prepared for cleaning, flushing, start-up of the new equipment and piping systems.

3. Contact: Roger Smith, Director of Process Control, 530 South 5th Street, Quincy, IL 62301, Office: 217-223-2019, Cell: 217-653-7538, Fax: 217-223-7734, roger@walterlouis.com.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 011000

SECTION 012200 – UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Unit Prices.

B. Related Sections include the following:

1. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

2. Division 03, Section 0337000, Concrete Repair, for procedures for measurement and payment for concrete repairs.

1.3 DEFINITIONS

A. Unit Price is an amount proposed by bidders, stated on the Bid Form Attachment 004322, a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit Prices include all necessary material plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of Unit Prices. Methods of measurement and payment for Unit Prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of Work in-place that involves use of established Unit Prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of Unit Prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each Unit Price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

A. After removal of steam engine generators, visually inspect and hammer sound engine room concrete floor, concrete floor beams, basement walls & basement columns below engine room.

Remove delaminated or damaged concrete & repair as required. Coordinate concrete inspection, removal, & repairs with owner's representative to allow for owner's observation.

B. Volume 2 - Unit Price No. 01 – Concrete Repairs:

1. Description: Removal of loose and deteriorated concrete and installation of patching material on existing concrete floors, beams, and columns, according to Division 03, Section 033700, Concrete Repair.
2. Unit of Measurement: Cubic Feet of Repair Mortar Placed.
3. Base Bid Quantity: 20 Cubic Feet of Repair Mortar Placed.

C. Volume 2 - Unit Price No. 02 – Concrete Reinforcement Repairs:

1. Description: Repair of damaged steel reinforcement in existing concrete floors, beams, and columns, according to Division 03, Section 033700, Concrete Repair.
2. Unit of Measurement: Pounds of reinforcement.
3. Base Bid Quantity: 100 Pounds.

END OF SECTION 012200

SPEC SECTION	TITLE	CATEGORY
024119	Selective Demolition	Construction Schedule
024119	Selective Demolition	Certification
028213	Friable and Non-friable Asbestos Removal	Certification
028213	Friable and Non-friable Asbestos Removal	Product Data
028213	Friable and Non-friable Asbestos Removal	List of Subcontractors
028213	Friable and Non-friable Asbestos Removal	Test Report
032000	Concrete Reinforcing	Shop Drawings
032000	Concrete Reinforcing	Product Data
032000	Concrete Reinforcing	Certification
033000	Cast-in-Place Concrete	Product Data
033000	Cast-in-Place Concrete	Shop Drawings
033000	Cast-in-Place Concrete	Certification
033000	Cast-in-Place Concrete	As-Builts
033000	Cast-in-Place Concrete	Test Report
037000	Concrete Repair	Product Data
037000	Concrete Repair	Operation / Maintenance Manual
037000	Concrete Repair	As-Builts
099100	Painting	Product Data
220505	Selective Demolition for Plumbing	Construction Schedule
220505	Selective Demolition for Plumbing	Certification
220529	Hangers and Supports for Plumbing	Product Data
220529	Hangers and Supports for Plumbing	Shop Drawings
221313	Facility Sanitary Sewers	Product Data
230505	Selective Demolition for HVAC	Construction Schedule
230505	Selective Demolition for HVAC	Test Report
230515	Variable-Frequency Motor Controllers - Manufacturer's Product Data Sheets (To be provided by RO water treatment equipment manufacturer.)	Product Data
230515	Variable-Frequency Motor Controllers - Manufacturer's Shop Drawings (To be provided by RO water treatment equipment manufacturer.)	Shop Drawings
230515	Variable-Frequency Motor Controllers - Manufacturer's Certified Test Reports (To be provided by RO water treatment equipment manufacturer.)	Test Report
230515	Variable-Frequency Motor Controllers - Letter from Manufacturer Cerifying Compatability with 480V, 3Φ, 3W GRD BΦ Power System (To be provided by RO water treatment equipment manufacturer.)	Certification
230515	Variable-Frequency Motor Controllers - Instruction Manuals (To be provided by RO water treatment equipment manufacturer.)	Operation / Maintenance Manual
230515	Variable Frequency Motor Controllers - Warranty (To be provided by RO water treatment equipment manufacturer.)	Warranty
230523	General Duty Valves for HVAC Piping	Product Data
230523	General Duty Valves for HVAC Piping	Certification
230523	General Duty Valves for HVAC Piping	Test Report
230523	General Duty Valves for HVAC Piping	Operation / Maintenance Manual
230529	Hangers and Supports for HVAC Piping and Equipment	Product Data
230529	Hangers and Supports for HVAC Piping and Equipment	Shop Drawings
230553	Identification for HVAC Piping and Equipment	Product Data
230553	Identification for HVAC Piping and Equipment	Sample
230700	HVAC Insulation	Product Data
230901	Instrumentation and Controls for HVAC - Power Plant	Product Data
230901	Instrumentation and Controls for HVAC - Power Plant	Shop Drawings
230901	Instrumentation and Controls for HVAC - Power Plant	Operation / Maintenance Manual
230901	Instrumentation and Controls for HVAC - Power Plant	Warranty
230901	Instrumentation and Controls for HVAC - Power Plant	Test Report
232000	Piping for HVAC	Product Data
232000	Piping for HVAC	Certification
232000	Piping for HVAC	Test Report
232116	Piping Specialties	Product Data
232116	Piping Specialties	Shop Drawings
232116	Piping Specialties	Test Report
232116	Piping Specialties	Operation / Maintenance Manual
232116	Piping Specialties	Warranty
232519.16	Reverse Omosis Water Treatment Equipment	Shop Drawings
232519.16	Reverse Omosis Water Treatment Equipment	Product Data
232519.16	Reverse Omosis Water Treatment Equipment	Test Report
232519.16	Reverse Omosis Water Treatment Equipment	Operation / Maintenance Manual
232519.16	Reverse Omosis Water Treatment Equipment	Warranty
232519.16	Reverse Omosis Water Treatment Equipment	As-Builts
232519.20	Reverse Omosis Water Treatment System Controls	Shop Drawings
232519.20	Reverse Omosis Water Treatment System Controls	Product Data
232519.20	Reverse Omosis Water Treatment System Controls	Test Report

SPEC SECTION	TITLE	CATEGORY
232519.20	Reverse Omosis Water Treatment System Controls	Operation / Maintenance Manual
232519.20	Reverse Omosis Water Treatment System Controls	Warranty
232519.20	Reverse Omosis Water Treatment System Controls	As-Builts
232519.30	Reverse Omosis Water Storage Tank	Shop Drawings
232519.30	Reverse Omosis Water Storage Tank	Product Data
232519.30	Reverse Omosis Water Storage Tank	Test Report
232519.30	Reverse Omosis Water Storage Tank	Operation / Maintenance Manual
232519.30	Reverse Omosis Water Storage Tank	Warranty
232519.30	Reverse Omosis Water Storage Tank	As-Builts
232519.40	Reverse Omosis Water Pumping System	Shop Drawings
232519.40	Reverse Omosis Water Pumping System	Product Data
232519.40	Reverse Omosis Water Pumping System	Test Report
232519.40	Reverse Omosis Water Pumping System	Operation / Maintenance Manual
232519.40	Reverse Omosis Water Pumping System	Warranty
232519.40	Reverse Omosis Water Pumping System	As-Builts
260505	Selective Demolition for Electrical - Schedule of Selective Demolition Activities	Construction Schedule
260505	Selective Demolition for Electrical - Inventory of Items to be Salvaged	Shop Drawings
260505	Selective Demolition for Electrical - Predemolition Photographs or Video	Shop Drawings
260505	Selective Demolition for Electrical - Disposal Records	Certification
260519	Low-Voltage Electrical Power Conductors and Cables - 600-volt Building Wire	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - 600-volt Multiconductor Control Cable	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - 600-volt Shielded Instrumentation Cable	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - CAT 5e Copper Ethernet Cable	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - Test Report	Test Report
260526	Grounding and Bonding for Electrical Systems - Grounding Conductors	Product Data
260526	Grounding and Bonding for Electrical Systems - Grounding Clamps	Product Data
260526	Grounding and Bonding for Electrical Systems - Grounding Connectors	Product Data
260529	Hangers and Supports for Electrical Equipment - Expansion Anchors	Product Data
260529	Hangers and Supports for Electrical Equipment - U-Channel Supports & Accessories	Product Data
260533.13	Conduit for Electrical Systems - Galvanized Rigid Steel Conduit	Product Data
260533.13	Conduit for Electrical Systems - Rigid Aluminum Conduit	Product Data
260533.13	Conduit for Electrical Systems - Liquidtight Flexible Metal Conduit	Product Data
260533.13	Conduit for Electrical Systems - Conduit Hubs	Product Data
260533.13	Conduit for Electrical Systems - Conduit Bodies	Product Data
260533.13	Conduit for Electrical Systems - Conduit Mounting Clamps	Product Data
260533.13	Conduit for Electrical Systems - Fire-Stopping Materials	Product Data
260533.16	Boxes for Electrical Systems - Outlet and Non-Dimensioned Junction and Pull Boxes and Device Boxes	Product Data
260533.16	Boxes for Electrical Systems - Dimensioned Junction and Pull Boxes	Product Data
260553	Identification for Electrical Systems - Nameplate Type Product Data	Product Data
260553	Identification for Electrical Systems - Nameplate Engraving Schedule	Shop Drawings
260553	Identification for Electrical Systems - Wire and Cable Identification Label Product Data	Product Data
260553	Identification for Electrical Systems - Conduit Marker Product Data	Product Data
260553	Identification for Electrical Systems - Arc Flash Hazard Warning Labels	Product Data
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Product Certificates for Software Programs Certifying Compliance with IEEE 399	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Qualification Data for Fault-Current Study and Arc Flash Risk Assessment Specialist	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Names of 3 Arc Flash Risk Assessments Performed in the Past Year	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Demostrate Capabilities in Providing Equipment, Services & Training to Reduce Arc Flash Exposure	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Demonstrate Experience in Providing Equipment Labels in Compliance with NFPA & ANSI Requirements	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Single-Line Diagram	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Fault Current Study Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Coordination Study Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Equipment Evaluation Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Overcurrent Protective Device Settings Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Arc Flash Risk Assessment Report	Shop Drawings

SPEC SECTION	TITLE	CATEGORY
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Final Report (2 Hardcopies & 1 CD to Include SKM Software Module)	Shop Drawings
260583	Wiring Connections - 600-Volt Connectors	Product Data
260583	Wiring Connections - 600-Volt Terminations	Product Data
260583	Wiring Connections - CAT 5e Copper Ethernet Connectors	Product Data
262813	Fuses - Each Type of Fuse	Product Data
262813	Fuses - Each Type of Fuse Reducer	Product Data
262813	Fuses - Each Type of Solid Copper Neutral Link (Dummy Fuse)	Product Data
262816.16	Enclosed Switches - Product Data Sheets (To be provided by RO water pumping system equipment manufacturer)	Product Data

SECTION 024119 – SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment, and services necessary to perform all demolition work.

B. Work included in this Section includes all demolition work as shown on the Drawings and as specified herein and as required to complete the Work.

1.3 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity, interruption of utility services, use of elevator and stairs, and locations of temporary partitions and means of egress.

B. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations.

C. Disposal Records: If hazardous wastes are removed by contractor, submit the following:

1. Hazardous Waste Transporter license
2. Permit or license for hazardous waste treatment or disposal facilities
3. Completed Uniform Hazardous Waste Manifest for all shipments

1.4 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

D. Prior to beginning demolition, arrange a conference with the Owner’s Representative to review demolition scope, procedures, schedule and items to be salvaged for the Owner.

1.5 PROJECT CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Owner's Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.7 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and coordinate and identify the extent of the demolition work required. Record existing conditions using preconstruction photographs.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner's Representative and Engineer.

E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.

F. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

A. No demolition work shall be performed without prior approval of the Owner's Representative.

B. Demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facility.

C. Any demolition work which interferes with Owner's operation shall be scheduled with the Owner's Representative and be subject to the Owner's approval.

D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.

E. Do not interrupt existing utilities serving occupied facilities except when authorized in writing by the Owner and authorities having jurisdiction.

F. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and Designer.

G. Unless noted otherwise, provide not less than two weeks of notice to the Owner if shutdown of service is required during the execution of the work.

H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Owner's Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. Existing building openings may be used to remove material. No new openings may be made without approval of the Owner's Representative.

3.4 PROTECTION

A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during demolition operations.

B. Provide dust control and ventilation as required in areas of demolition.

C. Execute demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas of building; maintain free and safe passage of persons around the areas of demolition.

D. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the demolition work.

E. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.

F. Protect existing surfaces, active utility services, and equipment which are to remain in place.

G. No blasting will be permitted.

3.5 DUST CONTROL

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's plant.

B. Adequacy of the dust control methods shall be subject to the approval of the Owner's Representative.

C. Areas of major demolition inside the Owner's plant shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.

D. Temporary enclosures shall be removed by the Contractor upon completion of the demolition work unless otherwise directed by the Owner's Representative.

3.6 DEMOLITION - GENERAL

A. Remove all work indicated on the drawings and as required to complete the new work indicated.

B. During demolition operations, keep areas adjacent to demolition work free of dust and debris.

C. During demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Owner’s Representative.

D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting demolition operations.

E. Neatly cut openings and holes plumb, square and true to dimensions, required.

F. Use cutting methods least likely to damage construction to remain or adjoining construction.

G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

I. Do not use cutting torches until work area is cleared of flammable materials.

J. Maintain portable fire-suppression devices during flame-cutting operations.

K. Contractor shall take care when using a torch to cut steel welded or bolted to the building structural members so as to cut flush with but not damage the building structural members.

L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.

M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.

N. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

O. Dispose of demolished items and materials promptly.

3.7 CONCRETE AND MASONRY DEMOLITION

A. Demolish concrete and masonry in small sections.

B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

C. Sidewalks, curbs, gutters, and pavement shall be neatly saw cut at existing joints where removal is required for new construction.

3.8 WALL AND FLOOR COVERING DEMOLITION

A. Wall covering removal and residual adhesive: as required to provide a wall substrate suitable for the application of the new wall finishes.

B. Carpet and residual adhesive removal: as required to provide a floor substrate suitable for the application of the new flooring.

C. Resilient floor covering and residual adhesive: Remove in accordance with the recommendations of the Resilient Floor Covering Institute (RFCI) "Recommended Work Practices for the Removal of Resilient Floor Coverings" and referenced applicable ASTM publications such as ASTM F-710 (latest version) Standard Practice for Preparing Concrete Floors and Other Monolithic Floors to Receive Resilient Flooring.

D. Remove residual adhesive. Leave floor suitable for the application of the new flooring contractor to prepare substrate for new floor coverings by one of the methods in the RFCI.

3.9 PIPING DEMOLITION

A. The Contractor shall use caution in the demolition of piping and shall inform himself of the conditions (fluid, pressure, temperature) of all piping systems to be demolished before making any cuts or breaking any joints.

B. Prior to breaking or cutting piping or tubing within the demolition area, the Contractor shall ascertain that the system has been marked in the field or shown on the Drawings to be wrecked

under this contract. Contact Owner's Representative for clarification prior to demolishing or wrecking questionable items.

C. Arrange for shutoff, isolation, and lock-out of piping with Owner's Representative or utility companies.

D. When indicated on the drawings, before proceeding with selective demolition, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

E. All remaining piping with open ends resulting from demolition work shall be promptly capped, plugged or blind flanged.

3.10 ELECTRICAL DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality and functionality.

B. The Contractor shall use caution in the demolition of electrical systems and shall inform himself of the status (active, inactive) of all electrical systems to be demolished prior to proceeding.

C. Prior to breaking or cutting conduit within the demolition area, the Contractor shall ascertain that the system has been identified or shown on the Drawings to be wrecked under this Contract. Contact the Owner's Representative for clarification prior to demolishing or wrecking questionable items.

D. The Contractor shall remove, cap and/or relocate equipment, outlets, lighting fixtures, conduit, wire, etc., as specified or as shown on the Drawings and as may become necessary because of existing field conditions at no additional cost to Owner.

E. All existing lighting fixtures, switches, receptacles, outlets, etc., shall be removed as required to complete the work and blank covers provided over the outlets, unless otherwise noted.

F. Properly dispose of all lighting fixture lamps and ballasts in accordance with all applicable Federal, State, and local laws, codes, and regulations.

G. All concealed conduit for circuits which are partially or completely abandoned may remain in place. Remove all wiring for concealed circuits that are to be completely abandoned and cut and remove concealed conduit 2 inches below the surface of adjacent construction. Cap conduits and patch surface to match existing finish and fire rating. Exposed conduit for abandoned circuits shall be removed, unless otherwise noted.

H. Exposed conduit containing circuits which are to be retained shall remain in place, unless otherwise indicated or required.

I. Wiring for existing circuits which must be rerouted, or which are partially abandoned, shall be reconnected to service the outlets/loads remaining on the circuit.

J. All wiring for a circuit which is to be removed or abandoned shall be removed back to the panel which supplied the circuit.

K. Completely remove all hangers and supports to building structure. Grind off stubs without damaging parent material (steel, concrete, etc.) and touch up paint as required.

L. All abandoned or remaining empty conduit with open ends resulting from demolition work shall be promptly capped, plugged, or sealed.

M. All open conduit knockouts, holes or unused hubs in electrical boxes and enclosures shall be properly plugged with suitable blanking devices that maintain the NEMA rating of the box or enclosure except that any unused conduit openings in the top, sides or back of a NEMA Type 1 electrical box or enclosure shall be sealed with a NEMA Type 12, gasketed hole sealing device.

3.11 PATCHING

A. All holes or openings in floors, walls or ceilings resulting from demolition shall be properly sealed with material similar to the adjacent surface/finish.

B. All rough edges of openings created by demolition shall be promptly patched to create a finished surface.

C. Openings in concrete shall be patched with cement mortar.

D. Openings in masonry shall be patched by toothing in masonry units to match existing.

3.12 REMOVED AND SALVAGED ITEMS

A. Carefully remove and clean salvaged items.

B. Pack or crate items after cleaning. Identify contents of containers.

C. Store items in a secure area until delivery to Owner.

D. Transport items to Owner's storage area on-site designated by Owner.

E. Protect items from damage during transport and storage.

3.13 REMOVED AND REINSTALLED ITEMS

A. Carefully remove items to be reinstalled.

B. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

C. Pack or crate items after cleaning and repairing. Identify contents of containers.

D. Protect items from damage during transport and storage.

E. Reinstall items in locations indicated.

F. Comply with installation requirements for new materials and equipment.

G. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

H. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

3.14 EXISTING ITEMS TO REMAIN

A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

B. When permitted by Owner's Representative, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.15 DISPOSAL

A. All debris resulting from demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Owner's Representative.

B. Storage of removed materials on site will not be permitted.

C. Sale of removed materials on-site will not be permitted.

D. Transport demolished materials off Owner's property and dispose of legally.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.16 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.

B. Return adjacent areas to condition existing before selective demolition operations began.

3.17 HAZARDOUS MATERIALS

A. The Owner, to the best of his knowledge, has identified hazardous materials, including friable asbestos, in the items to be demolished or the work areas.

B. Should the Contractor discover material requiring removal which is suspected to contain hazardous materials, do not disturb.

C. Contact and consult with the Owner's Representative prior to proceeding. The Owner's Representative shall direct the Contractor how to proceed.

END OF SECTION 024119

SECTION 028213 – FRIABLE AND NON-FRIABLE ASBESTOS SURVEY & REMOVAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions, apply to the Work specified in this Section.

1.2 SCOPE

A. Available information indicates project work areas have been abated of hazardous materials, except as specifically noted below. Complete a hazardous material survey of all work areas with a qualified independent subcontractor and submit results of survey. Address any additional suspected hazardous materials with construction representative.

1. Assume steam engine gaskets & seals contain asbestos. Abate as required.
2. Assume generator wiring contains asbestos insulation. Abate as required.
3. Assume steam engine generator coatings contain heavy metals. Abate as required.
4. Assume residual steam engine oil contains hazardous contaminants. Abate as required.

B. Any additional asbestos abatement, if required, will be executed in accordance with contract provisions for changes in the Work.

1.3 GENERAL

A. General: The work specified herein included the survey and abatement of asbestos containing materials by certified and registered persons who are knowledgeable, qualified and trained in the abatement, handling, and disposal of asbestos containing material, and subsequent cleaning of the affected environment.

B. The Contractor shall furnish all labor, material, equipment, testing, services, permits, insurance, notifications, necessary or required to perform the work in accordance with applicable local, state, and federal regulations for the abatement of asbestos containing materials and for other work as specified in this section or as indicated in associated drawings, sketches, or reports of the work.

C. All fees required for notification requirements, renotifications, and/or inspections by the regulatory agencies shall be paid by the Contractor. Bulk sample analysis information required by the Department of Natural Resources, U.S. Environmental Protection Agency or local authority having jurisdiction in conjunction with the notification shall also be provided by the Contractor unless provided within this section.

D. The Contractor shall provide qualified, independent, third party monitoring of the asbestos abatement contractor actually completing the asbestos abatement work.

1.4 DEFINITIONS

A. Abatement – Procedures to decrease or eliminate the source of fiber release from asbestos containing building materials. Includes encapsulation, enclosure, and removal.

B. Adequately Wet - To sufficiently mix or penetrate with liquid to prevent the release of particulate.

C. Aggressive Air Sampling - Sweeping of floors, ceilings and walls and other surfaces with the exhaust of a minimum of one (1) horsepower leaf blower or equivalent immediately prior to air monitoring.

D. Approved Waste Disposal Site - A solid waste disposal area that is authorized by the Department of Natural Resources to receive asbestos containing solid wastes.

E. Asbestos - The asbestiform varieties of serpentine (chrysotile, antigorite), riebeckite (crocidolite), cummintonite-grumerite (amosite), anthophyllite, and actinolite-tremolite.

F. Asbestos Abatement Supervisor - An individual who directs, controls, or supervises others in asbestos abatement projects.

G. Asbestos Containing Building Material (ACBM) - Surfacing ACM, thermal system insulation ACM, or miscellaneous ACM that is found in or on interior structural members or other parts of a building.

H. Asbestos Containing Material (ACM) - Any material containing more than 1 percent asbestos by weight.

I. Barrier - Any surface that seals off the work area to inhibit the movement of fibers.

J. Category I Nonfriable ACM - Asbestos-containing packings, gaskets, resilient floor covering and asphalt roofing products containing more than one percent (1%) asbestos as determined using the method specified in 40 CFR part 763, subpart F, Appendix A, section 1, Polarized Light Microscopy.

K. Category II Nonfriable ACM - Any material, excluding category I nonfriable ACM, containing more than one percent (1%) asbestos as determined using the methods specified in 40 CFR part 763, subpart F, Appendix A, section 1, Polarized Light Microscopy that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

L. Containment - Area where asbestos abatement project is conducted. Area must be enclosed either by a glove bag or plastic sheeting barrier.

M. Contractor’s Competent Person (Qualified Person) - One who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32 (f); in addition, for Class I, II, III, and IV work, who is specially trained in training courses which meet the criteria of EPA's Model Accreditation Plan (40 CFR Part 763) for project designer or supervisor, or its equivalent.

N. Decontamination Area - Enclosed area adjacent and connected to the regulated area which is used for decontamination of workers, materials, and equipment that are contaminated with asbestos.

O. Demolition - the wrecking or taking out of any load bearing structural member of a facility together with any related handling operations.

P. Disposal Bag - A properly labeled 6 mil. thick leak-tight plastic bag used for transporting asbestos waste from work area to disposal site.

Q. Encapsulant (Sealant) - A liquid material which can be applied to asbestos-containing material and which prevents the release of asbestos fibers from the material either by creating a membrane over the surface or by penetrating into the material and binding its components together.

R. Encapsulation - Treatment of asbestos containing materials with an encapsulant.

S. Enclosure - The construction of an airtight, impermeable, permanent barrier around asbestos containing material to control the release of asbestos fibers into the air.

T. Friable Asbestos Material - Any material containing more than one percent asbestos as determined using the method specified in appendix A, subpart F, 40 CFR part 763 section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

U. Glove Bag - A manufactured or fabricated device, typically constructed of six (6) mil transparent polyethylene or polyvinyl chloride plastic. This device consist of two (2) inward projecting long sleeves, an internal tool pouch and an attached, labeled receptacle for asbestos waste.

V. Homogeneous Work Site - Continuous areas with the same type of ACM and in which one type of abatement process is performed.

W. Negative Initial Exposure Assessment - An assessment by a "Competent Person" in which it is concluded that employee exposures during the job are likely to be consistently below the Permissible Exposure Levels.

X. Contractor's Third Party Air Monitoring Firm - Air Monitoring conducted by a person who is not under the direct control of the person carrying out the asbestos abatement project and who has been selected by the Contractor.

Y. Outside Air - Air outside of the containment.

Z. Contractor's Third Party Air Sampling Professional - An individual who holds a valid certification from the State of Missouri. The individual shall conduct, oversee, or be responsible for air monitoring of asbestos abatement projects before, during, and after the project has been completed. The air sampling professional must hold a 40 hour AHERA Asbestos Contractor/Supervisor Certificate, and supervised by the Contractor's Certified Industrial Hygienist (C.I.H.).

AA. Contractor's Third Party Air Sampling Technician - An individual who has been trained by and is under the supervision of an air sampling professional to do air monitoring before, during, and after the asbestos abatement project. The air sampling technician must hold a 40 hour AHERA Asbestos Contractor/Supervisor Certificate, and be supervised by the Contractor's Certified Industrial Hygienist (C.I.H.).

BB. Contractor's Third Party Certified Industrial Hygienist (C.I.H.) - an Industrial Hygienist, Certified in Comprehensive Practice by the American Board of Industrial Hygiene. The Contractor's C.I.H. must also be certified by the Missouri Department of Natural Resources as an air sampling

professional and hold a 40 hour AHERA Asbestos Contractor/Supervisor Certificate. The Contractor will identify C.I.H. before application for permit

CC. Personal Monitoring - Sampling of the asbestos fiber concentrations within the breathing zone.

DD. Regulated Asbestos Containing Material (RACM) - Friable asbestos material; Category I nonfriable ACM that has become friable; Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading; Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations.

EE. Remove - To take out RACM or facility components that contain or are covered with RACM from any facility.

FF. Renovation - Altering a facility or one or more facility components in any way, including the stripping or removal of RACM from a facility component.

GG. Repair - The restoration of asbestos material that has been damaged. Repair consists of the application of rewettable glass cloth, canvas, cement or other suitable material. It may also involve filling damaged areas with non-asbestos substitutes and re-encapsulating or painting previously encapsulated materials.

HH. Strip - To take off RACM from any part of a facility or facility components.

II. Waste Shipment Record - The shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of asbestos containing waste material.

JJ. Work Area - A specific isolated area, other than the space enclosed within a glove bag, in which friable asbestos-containing materials is required to be handled. The area is designated as a work area from the time that the area is secured and access restrictions are in place. The area remains designated as a work area until the time that it has been cleaned in accordance with any requirements applicable to the operations conducted.

1.5 CODES AND REGULATIONS

A. General Applicability Of Codes, Regulations and Standards – All applicable codes, regulations, standards, statutes, laws, and rules have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith. Where conflicts arise, the most stringent specification shall apply.

B. Contractor Responsibility - The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold the Owner harmless for failure to comply with any applicable work, hauling, disposal, safety, health, or other regulations on the part of the Contractor, Contractor's employees, or Contractor's subcontractors.

C. Federal and State requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following:

1. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) including but not limited to:

   a. Title 29, Part 1910, Section 1001 and Part 1926, Section 1101 of the Code of Federal Regulations
   b. Respiratory Protection, Title 29, Part 1910, Section 134 of the Code of Federal Regulations.
   c. Construction Industry, Title 29. Part 1926, of the Code of Federal Regulations.
   d. Access to Employee Exposure and Medical Records, Title 29, Part 1910, Section 2 of the Code of Federal Regulations.
   e. Hazard Communication, Title 29, Part 1910, Section 1200 of the Code of Federal Regulations.
   f. Specifications for Accident Prevention Signs and Tags, Title 29, Part 1910, Section 145 of the Code of Federal Regulations.

2. U.S. Environmental Protection Agency (EPA) including but not limited to:

   a. National Emission Standards for Hazardous Air Pollutants (NESHAPS) Title 40, Part 61, Subpart M, Code of Federal Regulations.

3. U.S. Department of Transportation (DOT) including but not limited to:

   a. Title 49, Part 172, Section 101 of the Code of Federal Regulations.

4. State of Missouri including but not limited to:

   a. H.B. 77, 85th General Assembly.
   b. Missouri Air Conservation Law Chapter 643.
   c. Missouri Department of Natural Resources, Division 10, Chapter 6 of the Code of State Regulations as follows:

      1) 10 CSR 10-6.020, Definitions
      2) 10 CSR 10-6.080, Emission Standards for Hazardous Air Pollutants
      3) 10 CSR 10-6.230, Administrative Penalties
      4) Volume 18, Missouri Register, Page 44
      5) 10 CSR 10-6.250, Asbestos Abatement Projects – Certification, Accreditation, and Business Exemption Requirements

1.6 NOTIFICATIONS

A. Notifications meeting the requirements of Volume 18, Missouri Register, page 44, shall be completed and sent by the Contractor not less than ten (10) days before the intended starting date of the project. Send notification to the following:

1. Department of Natural Resources
   Air Pollution Control Program (Asbestos)
   P.O. Box 176
   Jefferson City, Missouri 65102

2. U.S. Environmental Protection Agency
   Region VII
   Air & Toxic Division, Air Branch
   ATTN: Air Compliance
   726 Minnesota Avenue
   Kansas City, Kansas 66101
3. Provide a copy to the Owner's Representative. Five (5) day notification to the Owner's Representative is required on jobs less than the reportable quantity.
4. If the project is under the jurisdiction of the Kansas City Air Quality Section, St. Louis County Air Pollution Control Branch, or the Springfield-Green County Air Pollution Control Authority, send notification directly to the appropriate agency.

1.7 SUBMITTALS

A. Qualifications and current certificates for Contractor's Third Party Air Monitoring Firm, Air Sampling Professional, Air Sampling Technician, and Certified Industrial Hygienist.

B. The following will be submitted by Contractor prior to commencement of work with indication of review and approval by the Contractor's Third Party Certified Industrial Hygienist.

1. One copy of material safety data sheets (MSDS) for products to be used by the Contractor in the performance of his work. Contractor will also maintain copies of MSDS on site per OSHA.

2. One copy of the notifications to, or any correspondence with, the regulatory agencies. Submit a listing of all prior regulatory violations.

3. Friable Abatement:

   a. Current Certificates of training and statement of qualifications for the project asbestos abatement supervisor and the Missouri Asbestos Occupational Certificates for all project personnel. List a summary of project personnel and contact phone numbers.
   b. Name, address, and contact person's name of testing laboratory or laboratories to be utilized analyzing samples for bulk analysis or air samples.
   c. Submit a detailed plan of the procedures proposed for use in complying with requirements of this specification and Volume 18, Missouri Register, page 44, and 29 CFR 1926.1101. Include in the plan the layout and location of barriers, decontamination units, route of ingress and egress for work area, methods used to assure safety of building occupants and visitors, methods used to isolate or closing out of HVAC system, personal air monitoring strategy, method of removal of material, and engineering controls utilized to prevent emissions from the work area.
   d. Provide a disposal plan to detail type of disposal container, method of transportation to disposal site, waste hauler, and disposal site.
   e. Copy of notifications required as part of the emergency notification plan.

4. Non-Friable Abatement:

   a. Submit a detailed plan of the procedures proposed to minimize emissions and to prevent the material from becoming friable during removal.

b. Copy of emergency protection plan to be used if the nonfriable material should become friable during removal.
c. Current Certificates of training and statement of qualifications for the "Competent Person".
d. One copy of the Negative Initial Exposure Assessment.

C. Upon completion of the abatement work, the following information shall be submitted, with indication of review and approval by the Contractor's Third Party Certified Industrial Hygienist.

1. Waste disposal receipts and waste shipment record on all asbestos waste removed from the project.

D. Upon completion of the abatement work, the following information shall be submitted by the Contractor's C.I.H.

1. Air sampling test results for personal (non-OSHA) and final clearance air samples taken under the supervision of Contractor's Certified Industrial Hygienist. Results must be in writing in final report form.
2. Written certification from the Contractor's Certified Industrial Hygienist.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 SUPERVISION OF ABATEMENT

A. The Contractor shall designate a competent supervisor subject to the approval of the Contractor's C.I.H. and the Owner's Construction Representative. The supervisor shall be the Contractor's representative on the project and shall meet the requirements of all applicable regulations and perform the following minimum requirements.

1. Be Certified by the State of Missouri as an Asbestos Abatement Supervisor, a minimum of one year prior full time experience in asbestos abatement work and a minimum of two years experience as a supervisor, and be qualified as a Competent Person in accordance with OSHA regulation 1926.1101.
2. Be on site and supervise all abatement work in accordance with OSHA and Volume 18, Missouri Register, page 44.
3. Conduct all OSHA required air monitoring.
4. Maintain a daily log on the project documenting events, visitations, problems, equipment failures, accidents, and inspections.
5. Be responsible for implementation of first aid, safety training, respiratory protection, and ensuring all workers are trained in emergency procedures.
6. Be responsible for conducting a visual inspection of the work area prior to a visual inspection by the Owner's Certified Industrial Hygienist. Inspection shall be documented.

3.2 NEGATIVE INITIAL EXPOSURE ASSESSMENT

A. The Contractor must conduct a Negative Initial Exposure Assessment (non-friable asbestos) prior to removal of the asbestos material. The Negative Initial Exposure Assessment shall be performed by a "Competent Person" to determine whether the material may be removed and maintained in a nonfriable condition. If the material cannot be removed without becoming friable

then the Contractor shall comply with the requirements in this specification at no additional cost to the Owner.

B. The method of removal is the Contractor's option. However, in the event of any of the following:

1. Visible emissions are observed
2. Sanding, grinding, cutting, or abrading of the material
3. Air samples exceed 0.1 f/cc

The Contractor shall immediately stop work, implement corrective work practices, make any necessary notifications to all regulatory agencies of the changes in work practices and material conditions, and comply with the requirements as set forth in this specification.

3.3 WORKER PROTECTION & TRAINING

A. The Contractor shall be responsible for providing his employees with proper respiratory protection, respiratory training, written respirator program, medical examinations, maintaining medical records, and protective clothing and equipment to comply with OSHA requirements.

B. The Contractor shall be responsible for all testing and costs incurred for complying with requirements of OSHA regulations for Personal Air Sampling.

C. All workers shall be trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and protective measures.

D. All workers shall hold valid diplomas as accredited Asbestos Abatement Workers as required by 10 CSR 10-6.250.

3.4 INDEPENDENT TESTING LABORATORY

A. Testing Laboratories utilized by the Contractor for sample analysis during the project shall meet the following minimum requirements and be approved by the Contractor’s C.I.H. This information shall be submitted for review.

1. All air monitoring samples shall be analyzed by a testing laboratory accredited by the American Industrial Hygiene Association (AIHA) or by an individual who is currently on the Asbestos Analyst Registry.
2. All bulk samples shall be analyzed by a testing laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).

3.5 CONTRACTOR’S THIRD PARTY AIR SAMPLING PROFESSIONAL & CERTIFIED INDUSTRIAL HYGIENIST

A. It will be the Contractor’s responsibility to hire an Air Sampling Professional & Certified Industrial Hygienist. The Air Sampling Professional & Industrial Hygienist will also be required to perform the following duties as a minimum:

1. Approval of the Contractor's work plan and methods of abatement to meet regulatory requirements and ensure the health and safety of facilities faculty, staff, and students.
2. Verify that the Contractor is satisfactorily performing personal air monitoring as directed by OSHA regulations.

3. Visual inspection of the work area and final clearance air monitoring.
4. Certify in writing that the Contractor's procedures, methods and practices were, to the best of his knowledge and belief, in compliance with current EPA, OSHA, State and/or applicable local regulations and that the work areas meet the requirements for final clearance testing and account of any known deviations.
5. Issue final air clearance.

3.6 EMERGENCY PROTECTION PLAN

A. The Contractor shall be responsible for developing a written Emergency Protection Plan and shall maintain this plan on site. The plan shall include considerations of asbestos leakage from the site, fire, explosion, toxic atmospheres, electrical hazards, slips, falls, and heat related injury. All employees shall be instructed and trained in the procedures.

B. Emergency protection plan shall also include written notification of police, fire and medical personnel of the planned abatement activities, work schedule, and layout of work area, particularly barriers that may affect response capabilities.

3.7 LOCAL AREA PROTECTION & SITE SECURITY

A. The Contractor shall be responsible for all areas of the building used by him and/or subcontractors in the performance of the work. Contractor shall exert full control over the actions of all employees and other persons with respect to the use and preservation of the existing building, except such controls as may be specifically reserved to the Owner's.

B. Contractor has the right to exclude from the work area all persons who have no purpose related to the work or its inspection, and shall require all persons in the work area to observe the same regulations required of Contractor's employees.

C. The Contractor shall have control of site security during abatement operations in order to protect work environment and equipment. Contractor shall have the Owner's assistance in notifying building occupants of impending activity and enforcement of restricted access by Owner's employees.

D. The Contractor shall keep a minimum of two 10 lbs. type ABC fire extinguishers on site. One shall be maintained outside the work area and one inside the work area. The employees shall be trained in the operation of extinguishers.

E. Where areas cannot be isolated by existing walls and doors from employees, clients, or the public, barriers must be constructed of ½" plywood and 2"x4" framing 16" o.c. to isolate the area. The barriers must be installed in such a manner to prevent damage to existing walls, floors, or ceilings. Barrier may have a lockable door.

F. The Contractor shall maintain the work area free from rubbish, debris, and dirt and keep a clean, safe working area.

G. The Contractor shall provide warning signage around the regulated area as required by OSHA.

H. The Contractor shall isolate any and all air supply and returns to the abatement space as required by OSHA. Contractor shall coordinate with the Owner's Representative.

I. The Contractor shall keep all areas where adhesive stripper is in use (such as mastic removal) under negative pressure and exhausted to the outside ambient air.

3.8 FINAL CLEARANCE REQUIREMENTS (FRIABLE ASBESTOS)

A. Upon completion of the abatement work, the supervisor shall perform a visual inspection of the work area. If satisfactory, the supervisor shall then request the Contractor's C.I.H. or the C.I.H.'s air sampling technician to perform a visual inspection. When the Contractor's C.I.H. feels the area is ready based on the results of their visual inspection, the Contractor shall apply a lockdown encapsulant. Following application of lockdown encapsulant, the Contractor's C.I.H. shall perform the final clearance sampling for airborne fiber concentrations.

B. The Contractor's C.I.H. or designee will perform final clearance testing per the following requirements:

1. Aggressive sampling shall be required for all areas where removal has taken place with the exception of glove bag projects where nonaggressive sampling is permitted.
2. P.C.M. samples analyzed on site shall be counted by an accredited registered microscopist.
3. For areas specifically specified for clearance by Transmission Electron Microscopy, the method shall be NIOSH 7402.

C. Any work areas failing to meet the clearance requirements of this section shall be recleaned and retested at the Contractor's expense until satisfactory levels are obtained.

D. The Contractor's C.I.H. shall provide a written report of the air monitoring activities to the Contractor within 7 days after the final clearance testing.

3.9 REESTABLISHMENT OF THE WORK AREA AND SYSTEMS

A. Reestablishment of the work area shall only occur after the Contractor has received final clearance in writing from the Contractor's C.I.H.

B. All damage to finishes, equipment, and/or the area affected by the abatement shall be repaired by the Contractor to equal or better condition as it was prior to the work, at no cost to the Owner.

3.10 WASTE DISPOSAL

A. All asbestos containing waste and/or asbestos contaminated debris shall as a minimum be double bagged in approved 6 mil. disposal bags. Each bag shall be tagged to meet requirements of NESHAPS with an asbestos caution label and a source identification label.

B. Transportation shall meet the requirements of all regulatory agencies for asbestos containing materials and shall be transported in an enclosed truck.

C. The waste disposal site shall be approved by the Missouri Department of Natural Resources for asbestos disposal. A chain of custody letter/waste shipment record and disposal receipts shall be provided to the Owner for all materials disposed of.

3.11 DRAWINGS

A. Drawings, when provided, are not intended to be used for anything but a "reference" to the work area. Information is not specific to quantities or to exact location of ACM unless explicitly noted. Contractor will be required to field verify the conditions and quantities.

3.12 REPORTS

A. Reports, when provided, are intended to be used as a basis for the type and composition of the asbestos present for both bidding purposes and for the information required for the notifications to the governing agencies.

END OF SECTION 028213

SECTION 031000 – CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes formwork for cast in-place concrete.

1.3 RELATED SECTIONS

A. Section 032000 – Concrete Reinforcement

B. Section 033000 – Cast-In Place Concrete

1.4 REFERENCES

A. ACI 117 - Tolerances for Concrete Construction and Materials.

B. ACI 301 Structural Concrete for Buildings.

C. ACI 318 Building Code Requirements for Reinforced Concrete.

D. ACI 347 Recommended Practice for Concrete Formwork.

E. AF&PA - National Design Specifications for Wood Construction.

F. ASTM D 1752 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

G. SPIB - 1994 Standard Grading Rules for Southern Pine Lumber (and Supplements).

H. WCLIB Rule No. 17 - Standard Grading and Dressing Rules.

1.5 DESIGN REQUIREMENTS

A. The design, engineering, and construction of all form work shall be the responsibility of Contractor.

B. Design, engineer, and construct formwork, shoring and bracing to conform to design and code requirements with resultant concrete conforming to required shape, line, and dimension.

C. All formwork shall be designed for the loads, lateral pressures, and allowable stresses outlined in ACI 347, “Recommended Practice for Concrete Formwork” and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 347, ACI 301 and ACI 318.

B. For wood products furnished for Work of this Section, comply with applicable provisions of AF&PA National Design Specifications for Wood Construction.

C. Maintain one copy of each document on site.

1.7 COORDINATION

A. Coordinate this Section with other sections of work, which require attachment of components to formwork.

B. Place formwork to obtain sufficient concrete cover over reinforcement.

C. Coordinate this Section with other sections of the work, which require application of finishes or waterproofing to formed concrete surfaces.

1. Verify that formwork and accessories are compatible with concrete finishes, coatings, waterproofing systems, etc.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Exposed Concrete: Unless otherwise shown or specified, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faces or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.

B. Unexposed Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal, or other acceptable material.

C. Steel forms, if used, shall be flat and smooth, without dents, free of rust and shall be tight fitting for all exposed surfaces.

D. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

2.2 WOOD FORM MATERIALS

A. Lumber Forms: Use for edge forms and unexposed finish concrete. Boards shall be 6 inches or 8 inches in width, shiplapped or tongue and groove, “Standard” Grade Douglas Fir, conforming to WCLIB Standard Grading and Dressing Rule No. 17. Surface boards on four sides.

B. Plywood Forms: Use for exposed finish concrete. Forms shall conform to PS-1. Each panel shall carry the grade trademark of the APA/EWA and shall be full size 4-foot by 8-foot panels.

1. Plywood for surfaces to receive membrane waterproofing shall be a minimum of 5/8 inch thick and shall be APA “B-B Plyform Structural I Exterior” grade.

2. Plywood where “Smooth Finish” is required, as shown on Drawings, shall be “HD Overlay Plyform Structural I Exterior” grade, minimum of 3/4 inch thick.

2.3 PREFABRICATED FORMS

A. Manufacturers:

1. Aluma-Systems Inc., Burke Co.
2. Economy Forms Corp.
3. Molded Fiber Glass Concrete Forms Co.
4. Perma Tubes.
5. Sonoco Products Co.
6. Symons Corp.
7. Western Forms, Inc.

B. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

C. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

D. Pan Type: Steel of size and profile required.

E. Steel Forms: Sheet steel, suitably reinforced, and designed for the particular use shown on Drawings.

F. Form Liners: Smooth, durable, grainless and non-staining hardboard, unless otherwise shown on Drawings.

G. Framing, Studding and Bracing: Stud or No. 3 structural light framing grade.

2.4 METAL FORM DECK

A. Metal deck shall be fabricated from high strength steel sheets conforming to ASTM A653 having a minimum yield strength of 80,000 psi.

B. Deck shall be minimum 20-gauge, box rib with paint grip ASTM A653/A924 galvanized finish.

C. Deck shall be placed with the ribs perpendicular to the supports and shall be continuous to the extent possible. End laps when required shall be a minimum of 2". All sheets shall bear on concrete walls for 3" in accordance with the manufacturer's erection standards.

D. Welding washers shall be furnished as required. Sheetmetal end closers shall be furnished and installed to prevent concrete leaking from the forms.

E. Deck shall be provided as required during concrete placing to limit maximum fiber stress to 30,000 psi and deflection to 1/240 of the span under the slab dead load plus a 20 psf construction load.

2.5 FORMWORK ACCESSORIES

A. Form accessories to be partially or wholly embedded in the concrete shall be of a suitable commercially manufactured type.

B. Form Ties: Removable type, metal, adjustable length, cone type with waterproofing washer.

1. Ties shall have no metal within 1" of finished surface.

2. Ties shall leave holes not less than 1/2" nor more than 1" in depth.

3. Ties shall leave holes no larger than 1" diameter in concrete surface.

C. Spreaders: Standard, noncorrosive metal form clamp assembly, of type acting as spreaders and leaving no metal within 1 inch of concrete face. No wire ties, wood spreaders or through bolts will be permitted.

D. In walls reinforced with epoxy coated bars, spreader bars shall be epoxy coated.

E. Proprietary combination bar clips and spreaders used in walls with epoxy coated reinforcing bars shall be made of corrosion-resistant material or coated with dielectric material.

F. Form Anchors and Hangers: Anchors and hangers used for exposed concrete shall not leave exposed metal at surface. Hangers supporting forms from structural steel shall be symmetrically arranged on supporting members to minimize twisting or rotation of member. Penetration of structural steel members will not be permitted.

G. Form Release Agent: Colorless non-staining agent which will not absorb moisture or impair natural bonding or color characteristics of waterproofing or coating intended for use on concrete.

H. Corners: Chamfer; 1 inch by 1-inch size; maximum possible lengths.

I. Joint Filler: ASTM D 1752.

J. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and centers before proceeding with formwork. Ensure that dimensions agree with Drawings.

3.2 INSTALLATION

A. All footings and foundations shall be formed.

B. Pouring concrete against soil on the sides of the excavation will not be permitted unless shown on the Drawings.

C. Formwork - General: Sloped surfaces steeper than 1.5 horizontal to 1 vertical should be provided with a top form to hold the shape of the concrete during placement, unless it can be demonstrated that top forms can be omitted.

D. Construct forms to the correct shape and dimensions, mortar-tight, of sufficient strength, and so braced and tied together that movement of workers, equipment, materials, or the placing and vibrating of concrete shall not affect formwork and finished construction. Forms shall be strong enough to maintain their shape under all imposed loads.

E. Provide positive means of adjustment (wedges or jacks) of shores and struts.

F. Camber where necessary to assure level finished soffits unless otherwise shown on Drawings.

G. Verify horizontal and vertical positions of forms and correct inaccuracies before placing concrete in any form.

H. Complete wedging and bracing before placing concrete.

I. Take up all settlement during the concrete placing operations.

J. Forms for Surfaces to Receive Membrane Waterproofing: Use plywood or steel forms. After erection of forms, tape form joints to prevent protrusions in concrete.

K. Framing, Studding and Bracing: Space studs at 16 inches on center maximum for boards and 12 inches on center maximum for plywood.

1. Framing, bracing, centering, and supporting members shall be of adequate size and strength to carry safely, without deflection, all dead and live loads to which forms may be subjected and shall be spaced sufficiently close to prevent any bulging or sagging of forms.
2. of all beam forms shall be constructed of material a minimum of 2 inches thick.
3. bracing loads over base area on which bracing is erected.
4. When placed on ground, protect against undermining, settlement, or accidental impact.

L. Erect formwork, shoring, and bracing to achieve design requirements, in accordance with requirements of ACI 301.

M. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

N. Forms shall be constructed so that they can be removed without hammering or prying against concrete.

O. Obtain approval before framing openings in structural members that are not indicated on Drawings.

P. Provide chamfer strips on external corners of beams and pilasters.

Q. Do not reuse wood formwork more than 3 times for concrete surfaces to be exposed to view. Do not patch formwork.

3.3 APPLICATION FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Excess material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with concrete against which fresh concrete will be placed.

D. Do not apply form release agent where concrete surfaces will receive applied coverings such as a waterproof membrane that are affected by agent.

1. Soak inside surfaces of untreated forms with clean water.

2. Keep surfaces coated prior to placement of concrete.

E. Reuse and Coating of Forms: Thoroughly clean forms and reapply form coating before each reuse.

1. For exposed work, do not reuse any form which cannot be reconditioned to "like new" condition.

2. Apply form coating to all forms in accordance with the manufacturer's specifications, except where "scored finish" is required as shown on the Drawings.

3. Do not coat forms for concrete that is to receive a "scored finish".

4. Apply form coatings before placing reinforcing steel.

3.4 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required.

B. Accurately locate, set in place, and securely fasten items that will be cast directly into concrete.

C. Voids in sleeves, inserts, anchor slots, etc., shall be filled temporarily with readily removable material to prevent entry of concrete into the voids.

D. All embedded items shall be clean and free of oil and other foreign matter such as loose coatings of rust, paint, and scale. The embedding of wood in concrete shall be avoided except where specifically shown on the Drawings.

E. Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

F. Install accessories straight, level, and plumb. Ensure items are not disturbed during concrete placement.

G. Install waterstops continuous without displacing reinforcement. Heat seal joints watertight.

H. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

I. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

J. Form Ties: Use sufficient strength and sufficient quantity to prevent spreading of the forms. Place ties at least 1 inch away from the finished surface of the concrete.

1. Leave inner rods in concrete when forms are stripped.

2. Space all form ties to be equidistant, and symmetrical and lined up both vertically and horizontally unless otherwise shown on Drawings.

K. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

L. Construction Joints: Provide a surfaced pouring strip where construction joints intersect exposed surfaces to provide a straight line at joints. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage. Show no overlapping of construction joints, as closely as possible, to present the same appearance as butted plywood joints. Joints in a continuous line shall be straight, true, and sharp.

M. Embedded Items: Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features. No wood or uncoated aluminum shall be embedded in concrete. Obtain any required information pertaining to embedded items to be furnished for the work specified in other sections. Securely anchor all embedded items in correct location and alignment prior to placing concrete. Conduits and pipes, including those made of coated aluminum, must meet the requirements of ACI 318.

N. Openings for Items Passing Through Concrete: Frame openings in concrete where shown on the Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections. Coordinate all work of this nature in order that there shall be no unnecessary cutting and patching of concrete. Perform any cutting and repairing of concrete required as a result of failure to provide for such openings.

O. Screeds: Set screeds and establish levels for tops of concrete slabs and levels for finish on slabs. Slope slabs to drain where required or as shown on the Drawings. Before depositing concrete, remove all debris from the space to be occupied by the concrete and thoroughly wet all forms. Remove freestanding water.

P. Screed Supports: For concrete over waterproof membranes and vapor barrier membranes, use screeds supports of a cradle, pad or base type which shall not puncture the membrane. Staking through the membrane will not be permitted.

Q. Cleanouts and Access Panels: Provide removable cleanout sections or access panels at the bottoms of all forms to permit inspection and effective cleaning of loose dirt, debris, and waste material. Clean all forms and surfaces against which concrete is to be placed of all chips, saw dust and other debris and thoroughly blow out with compressed air just before concrete is placed.

3.5 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

B. Inspect erected formwork to ensure that work will provide a concrete surface suitable for exposure or for application of concrete finishes, coatings, waterproofing, etc.

C. Notify Owner's Representative after placement of reinforcing steel in the forms, but prior to placing concrete, so that inspection may be made.

3.6 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean out ports.

D. During cold weather, remove ice and snow from within forms. Do not use deicing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.7 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and the removal has been approved by Owner's Representative.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

D. Forms shall be left in place for not less than the total number of days as specified in ACI 347.

E. The Contractors registered engineer will determine the time and sequence of formwork and shoring removal for formwork supporting weight of concrete, such as beams, roof slabs, and self-supporting walls.

1. Contractor shall consider temperature, deadload, construction live loads, etc., in timing of formwork removal.

2. In any event, formwork supporting weight of concrete shall not be removed until concrete has reached compressive strength no less than 75% of the specified minimum 28-day compressive strength, and no sooner than seven (7) days.

3.8 ERECTION TOLERANCES

A. Formwork shall be constructed such that the finished concrete surfaces are free of any abrupt dimensional changes requiring extensive corrective work such as patching or grinding and that formed concrete will conform to dimensional tolerances as follows.

B. Construct formwork to maintain tolerances required by ACI 301.

C. Tolerances: Construct formwork so that concrete surfaces shall be within construction tolerances specified in ACI 117.

D. Above tolerances do not relieve Contractor from responsibility of adhering to closer tolerances where required to coordinate concrete work with work of various trades or to achieve special architectural details.

END OF SECTION 031000

SECTION 032000 – CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and place reinforcing bars, stirrups, ties, bar supports, spacers, accessories, chairs, welded wire fabric, etc., as shown on the Drawings and as specified herein and as required to complete the work.

1.3 RELATED SECTIONS

A. Section 031000 – Concrete Forming and Accessories

B. Section 033000 – Cast-In-Place Concrete

1.4 QUALITY ASSURANCE

A. All work shall comply with provisions contained in the following documents (latest editions):

1. ACI 301 – Specifications for Structural Concrete
2. ACI 315 – Manual of Standard Practice for Detailing Reinforced Concrete Structures
3. ACI 318 – Building Code Requirements for Structural Concrete
4. ACI SP-66 – ACI Detailing Manual
5. CRSI – Manual of Standard Practice of the Concrete Reinforcing Steel Institute
6. ASTM A 615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
7. ASTM A 1035 – Standard Specification for Deformed and Plain Low-Carbon, Chromium Steel Bars for Concrete Reinforcement
8. ASTM A 185 – Standard Specification for Steel Welded Wire Reinforcements, Plain, for Concrete
9. ASTM A 775 – Standard Specification for Epoxy-Coated Steel Reinforcing Bars

1.5 SUBMITTALS

A. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules, and supporting spacing devices.

B. Manufacturer's Certificate: Certify that products meet or exceeded specified requirements.

C. Certified copies of mill test reports of reinforcement material analysis.

1.6 COORDINATION

A. Coordinate with placement of formwork, formed openings and other Work.

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS

A. The form and size of bars shall be as shown on the Drawings.

B. Reinforcing steel shall conform to ASTM A 615. Bars shall be Grade 60, unfinished unless noted otherwise.

C. If required, epoxy coated reinforcement shall conform to ASTM A 775.

D. Wire fabric for reinforcement shall conform to ASTM A 185. Wire fabric shall be furnished in flat sheets not rolls.

2.2 ACCESSORIES

A. Tie wire for unfinished reinforcement shall be minimum 16 gage, annealed type, epoxy coated.

B. Tie wire for epoxy coated reinforcement shall be plastic coated 16-gauge black annealed wire.

C. Provide spacers, chairs, bolsters, supports, and other devices to properly space and support reinforcing bars and welded wire fabric, which are compatible with the waterproofing system.

D. Use plastic tipped accessories at exposed surfaces.

E. Epoxy coated reinforcing bars supported from formwork shall rest on coated wire bar supports or on bar supports made of dielectric material or other acceptable materials.

1. Wire bar supports shall be coated with dielectric material, compatible with concrete, for a minimum distance of 2 inches from the point of contact with the epoxy coated reinforcing bars.
2. Reinforcing bars used as support bars shall be epoxy coated.
3. In walls reinforced with epoxy coated bars, spreader bars shall be epoxy coated.
4. Proprietary combination bar clips and spreaders used in walls with epoxy coated reinforcing bars shall be made of corrosion-resistant material or coated with dielectric material.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Reinforcing steel shall be stored off the ground and protected from oil, or other deleterious materials. Epoxy coated reinforcing bars shall be stored on protective cribbing.

B. Clean oil, mud, loose rust and scale from reinforcing steel before concrete is placed.

C. Place in strict accordance with Drawings. Locate accurately in forms and hold firmly with approved supports and spacers to secure against displacement.

D. Use metal accessories to keep reinforcing clear distance from finish face of concrete surface as indicated on Drawings or required by applicable standards.

E. Do not displace or damage waterproofing membrane.

F. Accommodate placement of formed openings.

G. Cutting of bars shall be with mechanical saw only. Torch cutting will not be allowed.

H. Do not weld reinforcement unless noted on the Drawings.

I. Locate reinforcement splices not indicated on the Drawings, at point of minimum stress. Review location of splices with Engineer.

J. Any epoxy coated bars cut or welded such that coating is damaged shall be field coated with epoxy to match shop coat.

K. Coating damage to epoxy coated reinforcing bars due to handling, shipment, and placing need not be repaired where the damaged area is 0.1 square inches or smaller; damaged areas larger than 0.1 inches shall be field coated with epoxy to match shop coat. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2 percent of the total surface area in each linear foot of the bar.

L. Provide supervision during placing of concrete to watch reinforcing and reset any bars displaced by pouring operation.

M. For welded wire fabric lap adjoining pieces one full mesh and lace splices with 16-gauge wire. Offset end laps in adjacent widths to prevent continuous laps.

N. The Contractor shall notify the Owner's Representative at least 36 hours before commencing to place concrete for any major portion of the work in order to permit inspection of the reinforcing.

END OF SECTION 032000

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Cast-in-place concrete and accessories associated with concrete work.

1.3 RELATED SECTIONS

A. Section 031000 – Concrete Forming and Accessories

B. Section 032000 – Concrete Reinforcing

1.4 REFERENCES

A. ACI 301 – Structural Concrete for Buildings

B. ACI 302 – Concrete Floor and Slab Construction

C. ACI 304R – Measuring, Mixing, Transporting and Placing Concrete

D. ACI 305R – Hot Weather Concreting

E. ACI 306.1 – Cold Weather Concreting

F. ACI 308 – Curing Concrete

G. ACI 318 – Building Code Requirements for Structural Concrete and Commentary

H. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field

I. ASTM C 33 – Concrete Aggregates

J. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

K. ASTM C 94 – Ready-Mixed Concrete

L. ASTM C 150 – Portland Cement

M. ASTM C157 – Change of Hardened Hydraulic-Cement Mortar and Concrete

N. ASTM C 260 – Air Entraining Admixtures for Concrete

O. ASTM C 295 – Guide for Petrographic Examination of Aggregates for Concrete

P. ASTM C 309 – Liquid Membrane Forming Compounds for Curing Concrete

Q. ASTM C 457 – Microscopial Determination of Parameters of the Air-Void System in Hardened Concrete

R. ASTM C 494 – Chemicals Admixtures for Concrete

S. ASTM C 595M – Blended Hydraulic Cements (Metric)

T. ASTM C 618 – Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

U. ASTM C 989 – Ground Granulated Blast-Furnace Slag for use in Concrete and Mortar

V. ASTM D 994 – Preformed Expansion Joint Filler for Concrete (Bituminous Type)

W. ASTM C 1017 – Chemical Admixtures for Use in Producing Flowing Concrete

X. ASTM C 1107 – Packaged Dry, Hydraulic Cement Grout (Nonshrink)

Y. ASTM C 1202 – Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

Z. ASTM C 1240 – Silica Fume Used in Cementitious Mixtures

AA. ASTM C 1260 – Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

BB. ASTM D 1752 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

CC. ASTM C 1567 – Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)

DD. ASTM D 6690 – Concrete Joint Sealer, Hot-Poured Elastic Type

1.5 SUBMITTALS

A. Product Data: Submit data for bonding agent, joint devices, attachment accessories, form release agents, curing compounds, etc.

B. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent work.

C. Shop drawings for inserts.

D. Material Certificates: Submit mill certificates for the cement, supplementary cementitious materials, and admixtures intended for inclusion in the concrete mixtures.

1. Cement: Submit certification of compliance with ASTM C 150 for cement manufactured within 3 months of submittal date.

2. Fly Ash and Pozzolan: Submit certification of compliance with ASTM C 618 performed within 6 months of submittal date.

3. Ground Granulated Blast-Furnace Slag: Submit certification of compliance with ASTM C 989 performed within 6 months of submittal date.

4. Chemical Admixtures: Submit certificate of compliance with ASTM C 494 Level 1 or Level 2, performed within one year of the submittal date. If a chemical admixture does not fit into a defined C 494 type, admixture certificate shall provide documentation that the admixture has no detrimental effect on strength development, time of setting, shrinkage, air entrainment, scaling, and freeze-thaw resistance (ASTM C 666 Procedure A).

E. Project Record Documents:

1. Accurately record actual locations of embedded utilities and components that are concealed from view.

2. Submit upon request for record copies of all concrete delivery tickets.

3. Submit upon request for record copy of plan with locations and dates for concrete placements shown on drawing.

F. Aggregates: Submit test results for each aggregate intended for use in the concrete mixtures, showing conformance to ASTM C 33 and additional requirements as follows:

1. Aggregate source and identification

2. Maximum nominal aggregate size, gradation size number

3. Gradation analysis, including percentage retained and passing each sieve, and a graph of individual percentage retained versus sieve size

4. Quantity and identification of deleterious substances in the aggregates

a. The limits for deleterious materials contained in coarse aggregate as defined in ASTM C 33 – Table 3 Class 4S.

5. Submit complete data regarding concrete aggregates prior to any change in aggregate source.

G. Concrete Mixture Submittal: At least 30 days minimum prior to concrete placement, submit mixture proportions and prequalification test data for each type of concrete along with material certifications. Submit complete list of ingredients including type, brand, source, and amount of: cement, fly ash, ground-granulated blast-furnace slag, aggregates, and admixtures.

H. Construction Field Test Results: Fresh concrete properties, including slump, air content, temperature, and unit weight, and hardened concrete properties, such as strength, shall be measured and submitted for record.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Maintain one copy of each document on site.

C. Acquire cementitious materials and aggregate from same source contained in the submittals for all Work.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306.1 when concreting during cold weather.

1.7 COORDINATION

A. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland cement shall conform to ASTM C-150, and shall be Type I. High Early Strength Cement, Type III may be used only when authorized by Owner's Representative.

B. Water shall be potable, clean, fresh, and free from oil, alkali, organic matter, or other impurities.

C. Fine aggregate shall be clean, coarse, washed river channel sand, free from loam, clay, lumps, or other deleterious material, conforming to ASTM C33 "Specifications for Concrete Aggregate".

D. Coarse aggregate shall be clean, hard, washed, and screened river gravel or clean, hard limestone free from dust, flat friable or laminated particles and fine materials. Aggregate shall conform to ASTM C33. Coarse aggregate shall be well graded from fine to coarse. Size of coarse aggregate shall not exceed 3/4".

E. Flint and chert will be limited to 1% maximum, by weight of the coarse aggregate, in all exposed concrete (cast-in-place or precast). Lignite will be limited to 0.07%, by weight of the fine aggregate in all exposed concrete.

2.2 ADMIXTURES

A. Air Entrainment: ASTM C 260

B. Chemical: ASTM C 494, Type A - Water Reducing, Type B – Retarding, Type C – Accelerating, Type F - Water Reducing, High Range. Calcium chloride or accelerating admixtures containing calcium chloride shall not be used.

C. Fly Ash and Calcined Pozzolan: ASTM C 618

D. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 80, 100 or 120

E. Plasticizing: ASTM C 1017

2.3 ACCESSORIES

A. Bonding Agent: Polymer resin emulsion or Latex emulsion.

B. Non-Shrink Grout: ASTM C 1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 pounds per square inch in 48 hours and 5,000 pounds per square inch in 28 days.

2.4 JOINT DEVICES AND FILLER MATERIALS

A. Joint Filler: ASTM D 1752; closed cell molded vinyl foam, resiliency recovery of 95 percent if not compressed more than 50 percent of original thickness.

B. Horizontal Joint Sealant: Multi-component Jet-Fuel-Resistant Urethane Sealant for Concrete - Pourable, chemically curing elastomeric formulation complying with the following requirements: Urethane Formulation - ASTM C-920, Type M; Grade P; Class 25; Uses T, M, A, and O as applicable to joint substrates indicated.

C. Vertical Joint Sealant: Multi-component Urethane Sealant for Concrete: Multi-component, gun grade urethane formulation complying with ASTM C 920 for Type M; Grade NS, Class 25, Uses T, M, and O as applicable to joint substrates indicated.

D. Joint-Sealant Backer Materials: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.

E. Backer Strips for Cold Applied Sealants: ASTM D 1751; of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

F. Primers: Product recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint- sealant-substrate tests and field tests.

2.5 CONCRETE MIX

A. Comply with the concrete proportioning and test requirements included in Paragraph 3.15.

B. Mix concrete in accordance with ACI 301. Deliver concrete in accordance with ASTM C 94.

C. Select proportions for normal weight concrete in accordance with ACI 301 trial mixtures.

D. Optimize the combined aggregate gradation to minimize the paste content required to make workable concrete.

E. Use accelerating admixtures in cold weather only when approved by Owner's Representative. Use of admixtures will not relax cold weather placement requirements.

F. Admixtures containing ingredients corrosive to reinforcing steel such as chloride ion, bromide ion, or thiocyanate are not permitted.

G. Use set retarding admixtures during hot weather only when approved by the Owners Representative.

H. Add air entraining agent to normal weight concrete mix for work exposed to exterior.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify requirements for concrete cover over reinforcement.

B. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.2 PREPARATION

A. Prepare previously placed concrete surfaces by abrasive blast cleaning, to remove debris and laitance and expose aggregate. Thoroughly wet the substrate prior to placement of fresh concrete against prepared surface.

B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels in an approved grout, epoxy, or adhesive.

3.3 PROPORTIONING

A. Concrete shall be proportioned in accordance with ACI 211.1, "Standard Practice for Selecting Proportions for Normal and Heavyweight Concrete".

B. Provide a concrete mix having not less than the specified minimum 28 days compressive strength using Type I cement and a consistency that can be worked into corners and angles of the forms and around joints, waterstops, dowels, tie bars, and reinforcement without excessive spading or vibration, segregation or undue accumulation of water or laitance on the surface.

C. Concrete mixtures which have been designed, approved and tested shall be adjusted in the field from time to time when required to meet the varying conditions encountered during construction and to maintain the specified strength, air, and slump requirements. Only water reducing admixtures or super plastics may be added. Addition of water is <u>not</u> permitted.

D. The strength level of the concrete shall be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the compressive strength requirements specified and no individual strength test result falls below the specified compressive strength by more than 500 psi. Each compressive strength test result shall be determined by finding the average compressive strength of three cylinders tested at the age of 28 days.

3.4 MIXING

A. Only ready mixed concrete shall be used. Ready mixed concrete shall be mixed and transported to the job site in accordance with ASTM C94 "Specifications for Ready Mixed Concrete".

B. Discharge of the concrete from truck shall be completed within 90 minutes after the introduction of water to the cement. Discharge of concrete from a stationary truck body shall be within 45 minutes. The limitations above may be extended as approved by Owner's Representative if the concrete can be placed without addition of water to the batch to meet slump and placing requirements. In hot weather, or under conditions contributing to quick

stiffening of the concrete, the limitations above may be reduced as directed by Owner's Representative.

C. Any concrete developing a set before being placed or requiring additional water to restore its consistency shall not be used.

3.5 PLACING CONCRETE

A. Place and consolidate concrete in accordance with ACI 301 and ACI 318.

B. Notify Owner's Representative and testing agency a minimum of 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, embedded parts, and formed expansion and contraction joints are not disturbed during concrete placement.

D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

E. Place concrete continuously between predetermined expansion, control, and construction joints.

F. Do not interrupt successive placement; do not permit cold joints to occur.

G. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit the installation of their work; cooperate with other trades in setting such work, as required.

H. Water, wood scraps, paper and all foreign material shall be removed from the place of deposit before concrete is poured.

I. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing.

J. While the concrete is being poured, it shall be spaded, tamped and vibrated so as to thoroughly work it around all reinforcement and embedded items and into corners of forms and leave a dense smooth surface when the forms are removed. Vibrators shall not be used to move or transport the concrete inside the forms.

K. Special precautions shall be taken to avoid segregation of the concrete during handling and placing operations. Concrete shall be deposited through suitable chutes or in such manner as to avoid a drop of more than 4' at any point.

L. Do not place concrete on frozen ground. Do not place concrete during rain, sleet, or snow unless adequate protection is provided and the Owner's Representative approves.

M. Walking on concrete shall not be permitted for at least 24 hours after it has been placed in the forms and for such additional hours thereafter as the Owner's Representative may direct.

3.6 HOT WEATHER PLACING

A. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

B. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature, provided that the water equivalent of the ice is calculated to the total amount of mixing.

C. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

D. Wet forms thoroughly before placing concrete.

E. Do not use retarding admixtures unless otherwise accepted in mix designs.

3.7 COLD WEATHER PLACING

A. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures in compliance with ACI 306 and as herein specified.

B. When air temperature has fallen to, or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50°F and not more than 80°F, at point of placement.

C. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

D. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

3.8 CONCRETE FINISHING

A. Formed surfaces shall have the following finishes unless otherwise noted on the Drawings.

1. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work and not receiving waterproofing membrane. This is the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

2. Smooth Form Finish: For formed concrete surfaces exposed to view, or that are to be covered with a coating, or covering material applied directly to the concrete, such as waterproofing, dampproofing, painting or other similar system. This is the as-cast concrete surface as obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed. Finish shall be Class A in accordance with ACI 347.

3. Related Unformed Surfaces: At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and plane and finish with a texture matching adjacent formed surfaces. Continue final

surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown. Hand trowel tops of walls supporting precast concrete to a smooth, plane finish.

3.9 SLAB FINISHES

A. Slabs shall have following finishes unless otherwise noted on the Drawings:

1. Trowel Finish: Apply trowel finish to slab surfaces that are to be exposed to view and slab surfaces that are to be covered with resilient flooring, paint, or other thin film finish coating system. Surface plane tolerance shall not exceed 1/8" in 10' when tested with a 10' straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

2. Float Finish: Apply a float finish to all roof slabs.

3. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete sidewalks, platforms, steps and ramps, equipment pads, and elsewhere as shown on Drawings. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route.

B. Seal all interior concrete slab surfaces to be left exposed with hardener applied in accordance with manufacturer's specifications.

3.10 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Contractor shall have all equipment and material needed for curing and protection of the concrete on hand before actual concrete placement begins. The curing medium used shall be applied as soon as possible after placing to prevent checking and cracking and loss of moisture from all exposed surfaces of the concrete. Unhardened concrete shall be protected from heavy rains, flowing water, and mechanical injury (such as load stresses, heavy shocks, excessive vibration, and construction equipment, materials, or methods).

D. Concrete surfaces not in contact with forms shall be cured by one of the following methods:

1. Ponding or continuous sprinkling.

2. Application of absorptive mats or fabric kept continuously wet.

3. Application of waterproof sheet materials conforming to ASTM C171.

4. Application of a curing compound conforming to ASTM C309 in accordance with the recommendations of the manufacturer. Curing compounds shall be compatible with waterproofing system.

E. Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After removal of the forms the concrete shall be cured until the end of the curing period specified below by one of the methods specified above.

F. Curing shall be continued for at least 7 days in the case of all concrete except high-early-strength concrete for which the period shall be at least 3 days. Alternately, if tests are made on cylinders kept adjacent to the structure and cured by the same methods, curing may be terminated when the average compressive strength has reached 70% of the specified strength. The cost of molding and testing the cylinders to determine this time shall be borne by Contractor.

G. Cold Weather: When the mean daily outdoor temperature is less than 40°F, the temperature of the concrete shall be maintained between 50°F and 70°F for the required curing period specified above. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide. Contractor shall provide a temperature recording device indicating the high and low temperatures within the enclosure during the entire curing period.

H. Hot Weather: When conditions are such that the rate of evaporation is greater than the rate at which water rises to the surface of recently placed concrete (i.e., high concrete temperature, high air temperature, high wind, and low humidity, or combinations thereof), provision for wind breaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light-colored material shall be made in advance of placement to prevent plastic shrinkage cracking. Such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

I. Rate of Temperature Change: Changes in temperature of the air immediately adjacent to the concrete during the curing period shall be kept as uniform as possible and shall not exceed 5°F per hour or 20°F in any 24-hour period. After the curing period, changes in air temperature adjacent to the concrete shall not exceed 5°F per hour or 50°F in any 24-hour period.

J. Remove any curing materials containing waxes or other products that may interfere with adhesion of waterproofing membranes or coatings.

3.11 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 by ACI certified technicians.

B. The Contractor will retain the services of a testing firm.

C. The Contractor shall be responsible for scheduling the tests.

D. Provide free access to Work and cooperate with appointed firm.

E. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.

F. Concrete for casting test specimens and fresh concrete properties shall be sampled at the end of the chute in accordance with ASTM C 172.

G. No water other than the incidental water used to prewet the delivery chute and fins shall be added to the concrete after the truck leaves the batch plant, unless directed in writing by the Owners Representative.

H. Adjustment of slump on site shall only be accomplished by the addition of water reducing or plasticizing admixture. Admixture shall be placed directly onto the concrete and the revolving drum mixer shall mix at high speed for 5 minutes, or 100 revolutions, before discharge.

3.12 TESTS DURING CONSTRUCTION

A. The following sampling and testing shall be provided by the Contractor using an independent testing laboratory.

B. Sampling and testing for quality control during the placement of concrete shall include the following:

1. Slump: ASTM C143; one test for each set of compressive strength test specimens.

2. Compression Test Specimen: ASTM C31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

3. Compressive Strength Tests: ASTM C39; one set for each 25 cu. yds. or fraction thereof, of each concrete class placed in any one day; one (1) specimen tested at 7 days, two (2) specimens tested at 28 days, and one (l) specimen retained in reserve for later testing if required.

4. Two additional test cylinders shall be cast during cold weather concreting and shall be cured on the job site under the same conditions as the concrete it represents. Compressive strength of field cured cylinders shall be determined prior to form removal, and at 56 days age.

C. Obtain concrete for casting test samples after slump adjustment.

D. Tests for fresh concrete properties (slump ASTM C 143, air content ASTM C 231, temperature ASTM C 1064, and unit weight ASTM C 138) shall be performed whenever casting test cylinders.

E. Additional fresh concrete property tests shall be performed when requested by the Owners Representative.

F. When the total quantity of a given class of concrete is less than 10 cu. yds., the strength test may be waived by the Owner's Representative if, in his judgement, adequate evidence of satisfactory strength is provided.

G. When the strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

H. Test results will be reported in writing to the Owner's Representative, Engineer, and the Contractor on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design

compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

I. The strength level of the concrete shall be considered satisfactory if the averages of all sets of three consecutive 28-day strength test results equal or exceed the compressive strength requirements specified and no individual strength test result falls below the specified compressive strength by more than 500 psi.

J. Concrete which fails to meet the minimum of 28-day strength requirements shall constitute questionable concrete. Contractor has the option of removing and replacing the questionable concrete or of making additional tests at his expense to prove the concrete strength is in compliance with the Specifications. Additional tests shall consist of core specimens taken where directed by Owner's Representative and in accordance with ASTM C42. Concrete in the area represented by the core tests will be considered adequate if the average of three cores is at least 85% of the compressive strength specified and if no single core is less than 75% of the required compressive strength. If core tests fail to meet the minimum strength requirements, or if tests are required from which it is impractical to secure core samples in accordance with ASTM C42, then load tests may be made in accordance with ACI 318 Part 6, Chapter 20 to determine acceptability. Cost of this testing shall be borne by Contractor.

K. Concrete work failing to meet minimum strength requirements as determined by additional tests shall be removed and replaced as directed by Owner's Representative at Contractor's expense.

3.13 INSERTS

A. Contractor shall provide all inserts and other cast-in-place items as shown and called for on the Drawings.

B. Steel plate and structural shapes shall be ASTM A36 and shall be shop cleaned and hot-dipped galvanized per ASTM A123 (minimum 2 oz/sq.ft.).

3.14 PATCHING

A. Allow Owner’s Representative to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Owner’s Representative upon discovery.

C. Repair surface defects immediately after form removal. Surface defects include color and texture irregularities, honeycomb, rock pockets, voids over 1/4" in any dimension, spalls, ridges, and stains or discoloration that cannot be removed by cleaning.

D. Clean and thoroughly dampen tie holes and fill with patching mortar.

E. Remove ridges, honeycomb, rock pockets, voids, etc., down to solid concrete. Make edges of cuts perpendicular to the concrete surface. Before placing cement mortar or proprietary patching compound, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout, or proprietary bonding agent.

F. For surfaces exposed to view blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Compact mortar in place and strike-off slightly higher than surrounding surface.

G. If defects cannot be repaired, remove and replace concrete.

H. Use epoxy-based mortar for structural repairs.

I. Patch imperfections in accordance with ACI 301.

3.15 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.

B. Remedy for defective concrete (payment penalty, repair, or replacement) will be determined by Owner's Representative.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Owner's Representative for each individual area. Repairs made shall be in accordance with ACI 301.

3.16 SCHEDULE - CONCRETE TYPES AND TEST REQUIREMENTS

A. Concrete shall be Class A as specified on the following page.

Table 1 – Concrete Proportioning and Testing Requirements

Concrete Class	A
Materials and Proportions	
Cement, ASTM C 150	Type I/II
Supplementary Cementitious Materials, *cm*	50% max†
Maximum Aggregate Size	3/4 inch
Water-cementitious materials ratio, *w/cm*	0.40 max
Prequalification Requirements	
Aggregates	ASTM C 1260
Slump - ASTM C 143	6 to 8 in.
Chloride Content – ASTM C 1152	< 0.20% wt of cement
Air Content - ASTM C 231	6% to 8% - outdoors Not Required – indoors
Hardened Air Content - ASTM C457	>5% - outdoors Not Required - indoors
28-day Strength - ASTM C 39	4000 psi
Drying Shrinkage - ASTM C 157	Not Required
28-day Permeability – ASTM C 1202 Permeability	Not Required
Field Testing for Process Control	
Slump - ASTM C 143	6 to 8 in. at point of placement
Air Content - ASTM C 231	6% to 8% - outdoors Not required - indoors
28-day Strength - ASTM C 39	4000 psi
28-day Permeability – ASTM C 1202	Not Required

† Maximum combined supplementary materials content of ternary or quaternary blends. Limitations on supplementary materials shall include quantities contained in blended cement. Fly ash content shall not exceed 25%. Ground granulated blast-furnace slag content shall not exceed 45%.

END OF SECTION 033000

SECTION 033700 – CONCRETE REPAIR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall repair damaged concrete as shown on the drawings and specified herein.

B. After removal of steam engine generators, visually inspect and hammer sound engine room concrete floor, concrete floor beams, basement walls & basement columns below engine room.

1. Remove delaminated or damaged concrete & repair as required.
2. Coordinate concrete inspection, removal, & repairs with Construction Representative and Engineer to allow for Owner's and Engineer's observation.

1.3 UNIT PRICES

A. Concrete repairs will be reimbursed based upon unit prices.

B. Refer to Division 01, Section 012200, Unit Prices, for Base Bid quantities associated with concrete repairs.

C. Procedures for measurement and payment for concrete repairs shall be as follows:

1. Unit Price No. 01 – Concrete Repairs:
   a. Description: Removal of loose and deteriorated concrete and installation of patching material on existing concrete floors, beams, and columns.
   b. Unit of Measurement: Cubic Feet of Repair Mortar Placed.
   c. Retain and submit all repair mortar shipping documentation.
   d. Retain and submit all repair mortar empty containers, bags, etc. for verification of total cubic feet of mortar installed.
2. Unit Price No. 02 – Concrete Reinforcement Repairs:
   a. Description: Repair of damaged steel reinforcement in existing concrete floors, beams, and columns.
   b. Unit of Measurement: Pounds of reinforcement.
   c. Retain and submit all reinforcement shipping documentation.
   d. Submit photographs of reinforcement installed prior to placement of repair mortar. Include measuring tapes in photographs to indicate diameter and lengths of reinforcement installed.
   e. Submit calculations for pounds of reinforcement installed with photographs.

1.4 SUBMITTALS

A. Submit manufacturer's product data sheets for all materials to be used.

B. Submit manufacturer's instructions for the repair and corrosion control systems.

C. Submit photographs of repair areas as follows:

1. After damage concrete has been removed but prior to repair work.
2. After exposed concrete and reinforcement have been prepared.
3. After repairs are completed.

1.5 QUALITY ASSURANCE

A. All work shall be done in strict accordance with the manufacturer's recommendations and applicable American Concrete Institute bulletins:

1. ACI RAP-6, Vertical and Overhead Spall Repair by Hand Application

B. The Contractor shall clearly mark the areas to be repaired for the Owner's review and approval prior to commencing work.

C. Prior to proceeding with repairs, Contractor shall have a preconstruction meeting on site with certified field representative(s) from the manufacturer(s) of the repair materials and corrosion protection system.

1. The manufacturer's representative(s) shall provide training to contractor's personnel executing and supervising the repair work and to the Owner's Representative.
2. The training shall address the parameters, means, methods, and materials necessary to achieve proper repairs.

D. Following the preconstruction meeting, the manufacturer's field representative(s) shall observe and approve the first repair completed by the Contractor.

PART 2 - PRODUCTS

2.1 GENERAL

A. Specifications are based on Sika products. Equivalent products by approved manufacturers may be used.

2.2 COATINGS

A. Reinforcement anti-corrosion coating shall be a three-component, solvent-free, moisture-tolerant, epoxy-modified, cementitious material, Armatec 110 EpoCem, as manufactured by Sika Corporation, or approved equal by BASF, Conpro, or Euclid.

B. Concrete primer shall be a three-component, solvent-free, moisture-tolerant, epoxy-modified, cementitious material, Armatec 110 EpoCem, as manufactured by Sika Corporation, or approved equal by BASF, Conpro, or Euclid.

2.3 REPAIR MORTAR

A. Repair mortar shall be polymer-modified, cementitious repair mortar, Sika "SikaTop 123 Plus", or approved equal by BASF, Conpro, or Euclid.

2.4 CONCRETE REINFORCING

A. Comply with Section 032000, Concrete Reinforcing.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. The surface shall be mechanically prepared. Areas to be repaired shall be clean, sound and free of contaminants. All loose and deteriorated concrete shall be removed by mechanical means.

B. Chip concrete substrate to obtain a surface profile of ±1/16" in depth with a new fractured aggregate surface.

C. Area to be repaired shall be no less than 1/8" deep.

1. Saw cut edges of repair area perpendicular to the surface to 1/2" minimum depth to avoid feather edges.
2. Do not cut steel reinforcement.

D. Where exposed reinforcing steel is encountered the following procedures shall be used.

1. Chip out behind the reinforcing steel to a depth of about ¾".
2. Where corrosion of the reinforcing steel exists, continue concrete removal along the reinforcing steel until corrosion damage is minimal and will not interfere with the bond between the steel and repair materials.
3. If the reinforcing steel cross sectional area has been reduced by greater than 25%, advise the Owner's Representative prior to proceeding further.
4. Sandblast the reinforcing steel to remove all contaminants and rust.

E. For bid purposes, assume all repair areas have exposed steel reinforcing and that corroded steel does not extend beyond the repair area.

F. High pressure wash the repair area with potable water to remove chlorides.

3.2 ANTI-CORROSION APPLICATION

A. Apply anti-corrosion material with stiff bristle brush or spray, 20 mils thick covering all exposed reinforcing steel. Cure to tack-fee 2-3 hours.

B. Apply a second coat of 20 mils. Allow to dry again before applying repair mortar.

3.3 CONCRETE PRIMER

A. Apply concrete epoxy primer to profiled concrete surface prior to installing repair mortar.

B. Apply in full accordance with manufacturer's instructions.

C. Concrete substrate shall be saturated surface dry (SSD) with no standing water during application of primer and repair mortar.

3.4 REPAIR MORTAR

A. Prepare and apply mortar in full accordance with manufacturer's instructions.

B. While epoxy adhesive coat is still tacky apply repair mortar.

C. Minimum thickness of mortar shall be 1/8". Do not feather edges.

D. For applications greater than 1-1/2" in depth, apply repair mortar in lifts.

1. Score the top surface of each lift to produce a roughened surface for the next lift.
2. Allow preceding lift to reach final set.

E. Surface shall be neatly trowel finished and cured in accordance with manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to sample materials and perform tests as follows:

1. Patching Mortar, Packaged Mixes: 10 randomly selected samples tested according to ASTM C 928.
2. Patching Mortar, Field Mixed: 10 randomly selected samples tested for compressive strength according to ASTM C 109/C 109M.

END OF SECTION 033700

SECTION 099100 – PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall paint interior and exterior exposed items and surfaces as shown on the Drawings and specified herein.

B. In general, the work shall consist of painting all unfinished surfaces of equipment and materials provided under this contract and as noted, except for those items specifically noted herein as not requiring painting.

1.3 GENERAL

A. Paint shall be manufactured by Tnemec, Sherwin-Williams, or approved equal by PPG, unless otherwise specified herein.

B. Products supplied shall comply with all regulations governing the use of volatile organic compounds (VOCs).

1.4 SUBMITTALS

A. Submit product data sheets for paint.

B. Submit color charts for color selection.

PART 2 - PRODUCTS

2.1 MANUFACTUERS PRODUCTS

A. The following products are those of the acceptable manufacturers for the systems specified in Part 3.

Paint Type	System	Tnemec	Sherwin-Williams
Polyamide Epoxy Primer	I2, E2	Series 69 Hi-Build Epoxoline II	Recoatable Epoxy Primer, B67 Series
Acrylic Poly-urethane	I2, E2	Series 73 Endura-Shield	Hi-Solids Poly-urethane B65-300

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces for conditions detrimental to proper completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Starting of painting work will be construed as acceptance of surfaces and conditions within any particular area.

3.2 SURFACE PREPARATION

A. Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

C. Provide barrier coats over incompatible primers or remove and reprime as required.

D. Notify Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.

E. Existing Painted Surfaces:

1. Remove all loose and scaling paint.

2. Make sure that all paint remaining is adhered well to the surfaces.

3. Remove all grease, oil and other surface contaminates which would affect adhesion of the new paint finish.

4. Sand all surfaces for proper paint adhesion and to remove glossy areas in the existing paint finish.

5. Sand rough edges of bare areas to feather edge at adjacent sound paint.

3.3 PRIMING

A. Unless noted otherwise, shop priming of ferrous metal items is included in the specification section for the various items such as structural steel, miscellaneous metal, metal doors and frames, pipe hanging material, etc.

B. Bare surfaces to be painted shall be properly primed.

3.4 APPLICATION

A. Paint application shall be by spraying, brush or roller.

B. Paint shall be thinned in accordance with the manufacturer's recommendations only as necessary to provide the required workability.

C. Apply all products at the coverage rate necessary to produce manufacturer's recommended dry film thickness.

D. Coatings shall be applied uniformly, free from runs, skips, streaks, or brush marks.

E. All containers used for the storage, mixing and application of painting materials shall be clean and free of foreign materials and residue.

F. Materials not in actual use shall be kept in covered containers.

G. Materials shall be thoroughly mixed before and during application to obtain a mixture of uniform density.

H. Film formed on the surface of materials in containers shall be removed and, if necessary, the materials strained before using.

I. All paints and materials shall be delivered to the job in their original containers with labels intact and seals unbroken.

J. All coatings shall be applied in accordance with the manufacturer's printed directions for the paint used. No paint shall be applied until the preceding coat has dried.

K. Apply coatings only under the following prevailing environmental conditions:

1. Do not apply paint in snow, rain, fog, or mist, or when the relative humidity exceeds 85 percent, or at temperatures less than 5□F (3□C) above the dew point, or to damp or wet surfaces.

2. Apply water based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50□F (10□C) and 90□F (32□C).

3. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45□F (7□C) and 95□F (35□C).

4. The atmosphere is relatively free of airborne dust.

L. All surfaces receiving two (2) coatings of finish paint shall have a slight variation in color of first coat to distinguish it from the final coat.

3.5 CLEAN-UP AND PROTECTION

A. During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day.

B. Upon completion of painting work, clean window glass and other paint-spattered surfaces.

C. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

D. Protect work of other trades and Owner's property whether to be painted or not, against damage by painting and finishing work.

E. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Owner's Representative.

F. Provide "Wet Paint" signs as required to protect newly-painted finishes.

G. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.

H. At completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

3.6 ITEM TO BE PAINTED

A. Painting of items provided under the contract shall include, but not be limited to the following.

1. Structural steel.
2. Miscellaneous metal.
3. Frames at building penetrations
4. Uninsulated carbon steel piping.
5. Carbon steel pipe support beams, angles, channels, etc.

3.7 ITEM NOT TO BE PAINTED

A. The following shall not be painted.

1. Items with factory finish.
2. Concealed surfaces, unless otherwise indicated.
3. Finished metal surfaces such as anodized aluminum, stainless steel, copper.
4. Galvanized material except as noted.
5. Insulated Piping.
6. Equipment name plates.
7. Moving parts such as valve stems, stuffing boxes, operators, linkages, etc.
8. Concrete, unless otherwise indicated.
9. Electrical conduits.

3.8 INTERIOR PAINTING SYSTEMS

A. Paint systems for interior surfaces shall be as follows:

1. System I2: Ferrous metal
   a. 2 coat gloss finish/epoxy-urethane
   b. Surface Preparation – SSPC-SP6, Commercial Blast Cleaning
   c. Prime/spot prime – Polyamide epoxy primer at 4.0-6.0 mils DFT
   d. 2nd coat – Aliphatic Acrylic Polyurethane at 3.0-4.0 mils DFT

B. Painting includes, but is not limited to the following:

1. Structural steel.
2. Miscellaneous metal.
3. Frames at building penetrations
4. Uninsulated carbon steel piping.
5. Carbon steel pipe support beams, angles, channels, etc.

3.9 EXTERIOR PAINTING SYSTEMS

A. Paint systems for exterior surfaces shall be as follows:

1. System E2: Ferrous metal
   a. 2 coat gloss finish/epoxy-urethane
   b. Surface Preparation – SSPC-SP6, Commercial Blast Cleaning
   c. Prime/spot prime – Polyamide epoxy primer at 4.0-6.0 mils DFT
   d. 2nd coat – Aliphatic Acrylic Polyurethane at 3.0-4.0 mils DFT

B. Painting includes, but is not limited to the following:

1. Structural steel.
2. Miscellaneous metal.
3. Frames at building penetrations
4. Uninsulated carbon steel piping.
5. Carbon steel pipe support beams, angles, channels, etc.

3.10 PAINT COLORS

A. Coordinate paint color selections with Construction Representative and the facility's existing paint color coding systems.

B. Paint color for non-potable water systems shall be purple in accordance with the International Plumbing Code (latest edition).

END OF SECTION 099100

SECTION 220501 – GENERAL MECHANICAL REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The requirements of this section are applicable to all work performed under Division 22 – Plumbing.

1.3 COORDINATION

A. It is the intent of the Plumbing Division of these Specifications that all plumbing work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations shall operate as designed.

B. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's Representative.

C. The Contractor shall note that piping and equipment as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference free systems with proper clearance to facilities and equipment.

D. The Contractor shall note that configuration and dimensions of equipment may vary from that shown on the Drawings depending on the equipment supplied. The Contractor shall be responsible for making the necessary modifications to connecting piping, ducts, bases, etc. required by the equipment supplied.

E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

1.4 SUBMITTALS

A. Submittals shall be furnished under this Division for approval in accordance with the procedures outlined in Division 1 and the separate sections of this Division.

B. Submittals shall include complete data including physical dimensions and other information required for installation as well as performance capabilities and limitations. Provide schedules indicating locations when more than one type of an item is to be used. All shop drawings must be certified as being correct for the proposed work.

C. Shop drawings, brochures or catalog cuts showing more than one size or model shall be marked to indicate the size or model proposed for the particular application.

D. Prior to submitting for approval, submittals shall be coordinated with the work of all other trades.

E. Submittals shall be identified as to the specific equipment for which the submittal relates. Identification shall be by reference to equipment numbers as shown on the Drawing or by

reference to the appropriate Article of the Specifications in which the equipment is specified.

1.5 INSTRUCTION MANUALS

A. Instruction manuals shall be furnished to Owner's Representative prior to start-up. Manuals shall be bound with table of contents and tabs for each section. Each set is to include the following information for all equipment furnished:

1. Manufacturer's parts list identified with the make, model and serial number of the equipment furnished.
2. Schematic control, flow and wiring diagrams identifying the location and function of all system components, valves and controls.
3. Installation, operation, lubrication and maintenance instructions.
4. Manuals shall incorporate design basis, drawings, flow diagrams, brochures and operating instruction in sufficient detail to enable operators to understand the equipment or system, its operation, limitations and maintenance needs.

1.6 CODES AND STANDARDS

A. Governing federal, state and local laws, codes and standards constitute minimum requirements and strict compliance therewith is required unless supplemented and/or modified by more stringent requirements of the Contract Documents.

B. Installation of plumbing systems and equipment shall comply with all applicable codes. These shall include the latest edition of the following:

1. International Building Code
2. International Plumbing Code
3. International Mechanical Code
4. International Fuel Gas Code
5. International Fire Code

C. All equipment, apparatus and systems shall be fabricated and installed in complete accordance with the latest edition or revision of the following applicable regulations, standards and codes:

1. ANSI - American National Standards Institute
2. ARI - Air Conditioning and Refrigeration Institute
3. AABC - American Air Balance Council
4. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
5. ASME - American Society of Mechanical Engineers
6. ASSE - American Society of Sanitary Engineering
7. ASTM - American Society for Testing and Material
8. AMCA - Air Moving and Conditioning Association
9. AWS - American Welding Society
10. BOCA - Building Officials and Code Administrators
11. NFPA - National Fire Protection Association
12. IMC - International Mechanical Code
13. IPC - International Plumbing Code
14. NEC - National Electrical Code

15. NEMA - National Electric Manufacturers Association
16. NSF - National Sanitation Foundation
17. PDI - Plumbing and Drainage Institute
18. OSHA - Occupational Safety and Health Administration
19. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
20. UL - Underwriters Laboratories, Inc.

1.7 QUALITY STANDARDS

A. All materials and equipment furnished under these Specifications shall be new and to the extent possible, standard products of the various manufacturers except where special construction or performance features are called for. Where more than one of the specific items is required, all shall be of the same type and manufacture.

B. The product of manufacturers shall be acceptable only when that product complies with or is modified as necessary to comply with all specified and indicated requirements in the Contract Documents.

C. Materials and equipment not herein specified or indicated as to manufacture but necessary for complete functioning systems shall be provided from sources conforming to the quality levels and functional requirements for corresponding materials and equipment set forth herein.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. All equipment shall have factory applied permanent nameplates indicating the manufacturer's name, model and serial numbers, temperature and pressure design and any other data necessary to conform with specified requirements.

2.2 LIFTING ATTACHMENTS

A. All equipment requiring hoisting for installation and/or maintenance shall be provided with suitable lifting attachments by the manufacturer. Manufacturer's installation instructions shall detail correct lifting procedures to preclude equipment damage.

2.3 EQUIPMENT GUARDS

A. All rotating equipment including couplings, gear trains and belt drives shall be provided with adequate guards for personnel protection. Wherever possible, the guards shall be provided by the equipment manufacturer. The guards shall be supported to prevent vibration or interference with the rotating equipment and shall be removable. Guards shall conform to OSHA requirements.

2.4 EQUIPMENT PROTECTION

A. Equipment openings and connections shall be provided with adequate covers at the factory to protect the internals, threads and flanges and prevent entrance of any foreign matter prior to installation.

B. Exposed machined surfaces of equipment such as shafts, bearing surfaces, gasket surfaces, gears, etc., shall be provided with adequate protection at the factory to prevent physical damage and corrosion prior to installation.

2.5 PAINTING AND FINISHES

A. All purchased equipment shall have a factory applied standard finish of the manufacturer's standard color unless otherwise specified.

B. Finishes which are marred during shipping, handling or installation shall be touched up to match the original finish.

C. Field fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed, be thoroughly cleaned of dirt, rust, weld slag, grease or oil.

D. Comply with Division 09 requirements regarding paints and finishes.

1. Subject to approval of Construction Representative, small field-fabricated bare iron or steel items such as small pipe support members may be painted with one prime coat of rust inhibiting primer.

2.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with the manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by the Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's Representative prior to final acceptance of the equipment.

2.7 GROUT

A. Unless otherwise required by the equipment manufacturer, grout shall be non-metallic, non-shrink type, with 5000 psi compressive strength at 28 days.

PART 3 - EXECUTION

3.1 WORK VERIFICATION AND FIELD MEASUREMENTS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. Location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Owner's Representative shall be notified and any changes approved before proceeding with the work.

3.2 PERMITS AND INSPECTIONS

A. Contractor shall be responsible for obtaining the required permits governing the work from authorities having jurisdiction and shall assume the cost of permits and inspections.

B. Upon completion of work, Contractor shall furnish to the Owner certificates of inspection or approval from the authorities having jurisdiction, if certificates of inspection or approval are required by law or regulations.

3.3 RECORD DRAWINGS

A. Contractor shall keep a written record of all deviations in location or elevation of piping and any underground or concealed installation from that shown on the Drawings. Records shall consist of clearly marked Drawings which shall be submitted to the Engineer after completion of construction.

B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or bench mark. Utility services outside of buildings shall also show depth of burial or flow line with reference to the finished ground floor elevation.

3.4 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.5 FASTENING TO BUILDING STRUCTURES

A. The methods of attaching or fastening equipment or equipment supports or hangers to the building structure shall be subject to approval by the Owner's Representative at all times.

B. Cutting, burning, drilling, welding or the use of explosive driven fasteners on building structures shall require prior approval by the Owner's Representative for each type of application unless specifically shown on the Drawings.

C. Equipment or piping shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions unless specifically indicated on the Drawings.

3.6 THERMAL METAL JOINING AND CUTTING

A. All welding, brazing, soldering and cutting work shall conform to applicable provisions of the following codes and requirements:

1. ASME Boiler and Pressure Vessel Code
2. American National Standards Institute (ANSI) B31.1 (latest), Power Piping, and Addenda
3. American Welding Society (AWS) D1.1 (latest) Structural Welding Code

B. Welding shall be performed only by skilled welders.

C. Welders and welding procedures employed on pressure vessel or pressure piping work performed under the ASME/ANSI code shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code or with local codes where they take precedence. A record shall be maintained on the job showing the date and results of qualification test for each welder employed on the job for code welding. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner.

D. Welders and welding procedures employed on structural steel pipe and equipment supports shall be qualified by tests in the "Standard Qualification Procedure" of the AWS.

E. A record shall be maintained on the job showing the date and results of qualification test for each welder employed on the job.

F. Qualified weld procedures and one certified copy of the qualification test for each welder so employed shall be furnished to the Owner's Representative.

G. Welding electrode storage shall, at a minimum, comply with the requirements of AWS D1.1, ANSI B31.1, ASME Boiler and Pressure Vessel Code, or the electrode manufacturer, whichever is most stringent.

H. Contractor shall establish the proper quality control procedures and tests to insure that all welds comply with the applicable requirements of the codes referenced above.

I. The Contractor shall test all pipe welds for proper quality using nondestructive, ultrasonic testing procedures.

1. Testing shall be completed by Contractor’s third party, certified weld inspector.

J. Contractor shall complete any required repairs at Contractor’s cost.

K. All cutting residue shall be cleaned from the interior of pipes prior to welding or joining.

3.7 HOUSEKEEPING PADS AND ANCHOR BOLTS

A. Housekeeping pads shall be provided for all floor-mounted equipment. Unless otherwise shown, housekeeping pads shall be 4" high, 3000 psi concrete, with #4 reinforcing rods 12" on center each direction in center of pad.

B. The size and configuration of housekeeping pads and anchor bolt requirements shall be coordinated with and shall be suitable for the equipment to be installed. Contractor shall be responsible for coordinating all requirements prior to forming and pouring the pad.

C. Existing floor surface shall be roughened or epoxy binder applied prior to pouring pad. Pad shall be doweled to existing concrete with #4 reinforcing rods located 3" inside pad perimeter on 12" centers.

D. Anchor bolts and sleeves shall be furnished for equipment provided under this Division to suit the equipment.

3.8 GROUTING

A. All plumbing equipment and pipe supports sitting on concrete shall be properly shimmed with stainless steel metal shims and grouted.

B. Grout shall be placed to completely fill the area between the equipment and the concrete.

C. Hollow equipment frames shall be completely filled with grout if recommended by the equipment manufacturer.

3.9 CUTTING AND PATCHING

A. All required openings shall be cut by the Contractor.

B. Under no circumstances shall any structural members, loadbearing walls or footings be cut without first obtaining written permission from the Engineer and Owner's Representative.

C. Cutting shall be in accordance with the following.

1. Concrete or Masonry: All openings for pipe in concrete or masonry materials shall be core drilled. Square or rectangular openings shall be saw cut as necessary.

2. Grating and Floor Plate: Openings in grating and steel floor plate shall be neatly cut without irregular edges.

3. Roofing: All penetrations of roofing shall be made in strict accordance with manufacturer's recommended details so as not to void warranty.

D. Patching shall be in accordance with the following.

1. Concrete or Masonry: Install sleeves for piping penetrations in accordance with Section 232000. Patch the opening with grout finished smooth with adjacent surface.

2. Grating: All openings cut in grating shall be banded.

E. All below grade openings for pipe shall be sealed with interlocking synthetic rubber link assembly, Link-Seal by Thunderline Corporation or equal.

3.10 START-UP AND TESTS

A. The Contractor shall start-up the plumbing systems with his own personnel after obtaining approval for start-up from Owner’s Representative. Owner's personnel shall be in attendance.

B. The Contractor's performance of the start-up shall not constitute acceptance. The Work shall remain the responsibility of the Contractor until final acceptance.

C. Any equipment or system placed in temporary operation for testing or for the convenience of Contractor during construction and before Owner takes over operation shall be properly operated and maintained by Contractor.

D. All equipment and systems shall be protected against freezing, flooding, corrosion or other form of damage prior to acceptance by the Owner.

E. Material or equipment damaged, shown to be defective, or not in accordance with the Specifications, shall be repaired or replaced to the satisfaction of Owner's Representative.

F. Before starting up any system, each piece of equipment comprising a part of the system, shall be checked for proper lubrication, drive rotation, belt tension, continuity of controls, and any other condition which may cause damage to equipment or endanger personnel.

G. Contractor shall provide a competent service representative trained in starting up and servicing the respective equipment for which he is responsible. Service representative shall be present to supervise the start-up of equipment and/or systems and training the Owner’s personnel.

H. Test runs shall be made over the full design load range when possible, or simulated to the satisfaction of Owner's Representative for other conditions. Tests shall continue for as long as necessary to demonstrate that systems will operate as designed.

I. During start-up all necessary adjustments shall be made, controls checked for proper operation, motors checked for possible overload, and the entire system checked by Contractor for any abnormal condition.

J. During the start-up and prior to acceptance of any system, Owner's designated operating personnel shall be instructed in the operation and maintenance of the system.

K. After start-up has been concluded and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipe line strainers and filters shall be cleaned, air filters cleaned or replaced, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required. Temporary piping, ducting, wiring, instrument connections, etc., shall be removed, and openings restored in a permanent manner acceptable to Owner's Representative.

L. All tests shall be made after notification to and in the presence of the Owner's Representative and the authorities having jurisdiction.

END OF SECTION 220501

SECTION 220505 – SELECTIVE DEMOLITION FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment and services necessary to perform all demolition work.

B. Work included in this Section includes all demolition work as shown on the Drawings and as specified herein and as required to complete the Work.

1.3 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity and interruption of utility services.

B. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finished surfaces, which might be misconstrued as damage caused by selective demolition operations.

C. Disposal Records: If hazardous wastes are removed by contractor, submit the following:

1. Hazardous Waste Transporter license
2. Permit or license for hazardous waste treatment or disposal facilities
3. Completed Uniform Hazardous Waste Manifest for all shipments

1.4 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

D. Prior to beginning demolition, arrange a conference with the Owner’s Representative to review demolition scope, procedures, schedule and items to be salvaged for the owner.

1. The Owner retains the right of first refusal on all items shown to be removed by the Contractor.

1.5 PROJECT CONDITIONS

A. Owner will occupy site and buildings immediately adjacent to selective demolition areas. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Owner's Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection and life safety facilities in service during selective demolition operations.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.7 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and coordinate and identify the extent of the demolition work required. Record existing conditions using preconstruction photographs.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

D. When unanticipated site, mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner's Representative and Engineer.

E. Engage a professional engineer to survey conditions of existing structures to determine whether excavations or the removal of any element might result in structural deficiency or unplanned collapse of any portion of existing structures during selective demolition operations.

F. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

A. No demolition work shall be performed without prior approval of the Owner's Representative.

B. Demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.

C. Any demolition work which interferes with Owner's operation shall be scheduled with the Owner's Representative and be subject to the Owner's approval.

D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.

E. Do not interrupt existing utilities serving occupied facilities except when authorized in writing by the Owner and authorities having jurisdiction.

F. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

G. Unless noted otherwise, provide not less than two weeks' notice to the Owner if shutdown of service is required during the execution of the work.

H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Owner's Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. Existing building openings may be used to remove material. No new openings may be made without approval of the Owner's Representative.

3.4 PROTECTION

A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during demolition operations.

B. Comply with the International Fire Code including the requirements for fire safety during demolition and construction and for welding and other hot work.

1. Maintain a hot work program permit system, including fire watch.
2. Maintain portable fire-suppression devices in work areas.
3. Minimize hot work within occupied buildings.

C. Provide dust control and ventilation as required in areas of demolition.

D. Execute demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas; maintain free and safe passage of persons around the areas of demolition.

E. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the demolition work.

F. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.

G. Protect existing surfaces, active utility services, and equipment which are to remain in place.

H. No blasting will be permitted.

3.5 DUST CONTROL

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's property.

B. Adequacy of the dust control methods shall be subject to the approval of the Owner's Representative.

C. Areas of major demolition inside the Owner's property shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.

D. Temporary enclosures shall be removed by the Contractor upon completion of the demolition work unless otherwise directed by the Owner's Representative.

3.6 DEMOLITION - GENERAL

A. Remove all work indicated on the drawings and as required to complete the new work indicated.

B. During demolition operations, keep areas adjacent to demolition work free of dust and debris.

C. During demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Owner’s Representative.

D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting demolition operations.

E. Neatly cut openings and holes plumb, square and true to dimensions, required.

F. Use cutting methods least likely to damage construction to remain or adjoining construction.

G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

I. Do not use cutting torches until work area is cleared of flammable materials.

J. Maintain portable fire-suppression devices in the area during flame-cutting operations.

K. Contractor shall take care when using a torch to cut steel welded or bolted to structural members so as to cut flush with but not damage the structural members.

L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.

M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.

N. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

O. Dispose of demolished items and materials promptly.

3.7 CONCRETE AND MASONRY DEMOLITION

A. Demolish concrete and masonry in small sections.

B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

C. Sidewalks, curbs, gutters and pavement shall be neatly saw cut at existing joints where removal is required for new construction.

3.8 PIPING DEMOLITION

A. The Contractor shall use caution in the demolition of piping and shall inform himself of the conditions (fluid, pressure, temperature) of all piping systems to be demolished before making any cuts or breaking any joints.

B. Prior to breaking or cutting piping or tubing within the demolition area, the Contractor shall ascertain that the system has been marked in the field or shown on the Drawings to be removed under this contract. Contact Owner's Representative for clarification prior to demolishing or removing questionable items.

C. Arrange for shutoff, isolation, and lock-out of piping with Owner’s Representative or utility companies.

D. When indicated on the drawings, before proceeding with selective demolition, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems.

E. All remaining piping with open ends resulting from demolition work shall be promptly capped, plugged or blind flanged.

3.9 PATCHING

A. All holes or openings in floors, walls or ceilings resulting from demolition shall be properly sealed with material similar to the adjacent surface/finish.

B. All rough edges of openings created by demolition shall be promptly patched to create a finished surface.

C. Openings in concrete shall be patched with cement mortar.

D. Openings in masonry shall be patched by toothing in masonry units to match existing.

3.10 REMOVED AND SALVAGED ITEMS

A. Carefully remove and clean salvaged items.

B. Pack or crate items after cleaning. Identify contents of containers.

C. Store items in a secure area until delivery to Owner.

D. Transport items to Owner's storage area as directed by Owner's Representative.

E. Protect items from damage during transport and storage.

3.11 REMOVED AND REINSTALLED ITEMS

A. Carefully remove items to be reinstalled.

B. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

C. Pack or crate items after cleaning and repairing. Identify contents of containers.

D. Protect items from damage during transport and storage.

E. Reinstall items in locations indicated.

F. Comply with installation requirements for new materials and equipment.

G. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

H. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

3.12 EXISTING ITEMS TO REMAIN

A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

B. When permitted by Owner's Representative, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.13 DISPOSAL

A. All debris resulting from demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Owner's Representative.

B. Storage of removed materials on site will not be permitted.

C. Sale of removed materials on-site will not be permitted.

D. Transport demolished materials off Owner’s property and dispose of legally in accordance with Federal, State, and local laws and regulations.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.14 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.

B. Return adjacent areas to condition existing before selective demolition operations began.

3.15 HAZARDOUS MATERIALS

A. The Owner, to the best of his knowledge, has identified hazardous materials, including friable asbestos, in the items to be demolished or the work areas.

B. Should the Contractor discover material requiring removal which is suspected to contain hazardous materials, do not disturb.

C. Contact and consult with the Owner's Representative prior to proceeding. The Owner's Representative shall direct the Contractor how to proceed.

END OF SECTION 220505

SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all pipe hangers, supports, and supplementary structural steel beams as required for the plumbing piping and equipment systems.

1.3 DELEGATED DESIGN

A. Detailed design of mechanical pipe supports and seismic restraints is the Contractor's responsibility, except for pipe hangers specifically identified on the drawings.

B. Provide pipe supports and seismic-restraints complying with the requirements of the applicable International Building Codes, ASME Codes, and industry standards (e.g. MSS SP-58, Pipe Hangers and Supports and MSS SP-127, Bracing For Piping Systems: Seismic - Wind - Dynamic Design, Selection, And Application).

1.4 SUBMITTALS

A. Product data sheets for pipe hangers, supports, expansion bolts, adhesive anchors, dielectric materials, and spring hangers.

B. Shop drawings for pipe support structural steel and seismic restraints.

PART 2 - PRODUCTS

2.1 PIPE SUPPORT COATINGS

A. All pipe support materials located outdoors shall be galvanized.

2.2 MANUFACTURERS

A. Manufacturer's figure numbers indicated herein or shown on the Drawings are Anvil and are for clarification purposes.

B. Equivalent material by Basic Engineers, Inc. or Bergen-Paterson may be used.

2.3 HANGER RODS

A. Hanger rods shall be electro-galvanized machine threaded rods (Fig. 140, 253) ASTM A36 or ASTM A575 with threads conforming to ANSI B1.1.

B. Minimum rod size shall be as follows:

Pipe Size	Hanger Rod Diameter
2" and under	3/8"
2-1/2", 3"	1/2"
4"	5/8"
6"	3/4"
8" thru 12"	7/8"
14" thru 18"	1"
20" thru 24"	1-1/4"

2.4 SADDLES AND SHIELDS

A. Hot, insulated, horizontal piping shall have pipe covering protection saddles (Fig. 160-166A) at all support points.

B. Saddle depth shall be equal to or slightly greater than insulation thickness.

C. Cold, insulated, horizontal piping shall have galvanized insulation protection shields (Fig. 167) at all support points.

2.5 HANGERS

A. Unless otherwise shown or specified, hangers for horizontal piping shall be as follows:

1. Uninsulated pipe: Adjustable clevis, (Fig. 260).
2. Insulated Pipe – Hot (200°F or less): Adjustable clevis, (Fig.260).
3. Insulated Pipe - Hot (212°F and above):
   a. 2-1/2" and under: Adjustable clevis, (Fig. 260)
   b. 3" and above: Adjustable steel yoke pipe roll, (Fig. 181)
4. Insulated Pipe - Cold: Adjustable clevis, (Fig. 260)
5. Copper Pipe: Adjustable tubing ring, plastic coated (Fig. CT-99C)
6. Plate Lugs: Forged steel clevis, (Anvil Fig. 299 or equal)

B. Unless otherwise shown or specified hangers for vertical piping shall be riser clamps (Fig. 261) installed below hubs, or lugs welded to the pipe or clevis with a plate lug welded to elbow at top of riser.

2.6 UPPER ATTACHMENTS

A. Unless otherwise shown or specified upper attachments shall be as follows:

1. 2" and under (optional): C-clamp with locknut (Fig. 86)
2. 4" and under: Malleable beam clamp with extension piece (Fig. 229) or welded beam attachment (Fig. 66) with bolt and weldless eye nut (Fig. 290).
3. 6" and above: Beam clamp with weldless eye nut (Fig. 292) or welded beam attachment (Fig. 66) with bolt and weldless eye nut (Fig. 290).

B. Unless otherwise shown or specified upper attachments for structural concrete ceilings shall be as follows:

1. Concrete single lug plate (Anvil Fig. 47 or equal) or clevis plate (Anvil Fig. 49 or equal). Expansion anchors shall be stainless steel.

2. For pipe 3" and under (optional): Carbon steel, drop-in type female expansion anchor.

C. Provide medium welded steel brackets (Fig. 195) for small bore pipe (2" or less) supported from concrete or masonry walls, if shown on Drawings.

D. Piping 2-1/2" and smaller may be supported eccentrically (9" maximum) with 3 x 3 x 1/4" angles welded to columns or beams which are at least 8" deep.

E. Not more than one eccentric attachment per beam will be permitted.

2.7 COPPER PIPE

A. Unless shown otherwise in the Drawings, copper piping shall be supported as follows:

1. Copper finished extension split tubing clamp (Anvil Fig. CT-138R or approved equal).
2. Copper plated adjustable clevis (Anvil Fig. CT-65 or approved equal).

B. Copper pipe shall be isolated from steel pipe support members with minimum 1/8" thick rubber sheet.

2.8 U-BOLTS

A. U-bolts for steel pipe shall be carbon steel furnished with four hex nuts and two jam nuts. (Anvil Fig. 137 or approved equal).

B. U-bolts for copper pipe shall be plastic coated carbon steel with hex nuts. (Anvil Fig. 137C or approved equal).

2.9 TUBE SUPPORT

A. Tubing for instrumentation and controls shall be supported with James C. White Company, Inc., "Tubetrack" or equal.

2.10 PIPE STANCHIONS

A. Pipe stanchions shall be Fig. 63 or field fabricated equal from Schedule 40 pipe and 3/8" thick base plate.

B. Stanchion size shall be half the size of the pipe being supported but not less than 2" diameter.

C. Stanchion base plate shall <u>not</u> sit directly on floor but shall have minimum 1" non-metallic, non-shrink grout underneath.

D. Bolt base plate to floor with minimum ½" stainless steel expansion anchors.

2.11 PIPE SUPPORT STRUCTURAL STEEL

A. Wide flange beams shall be ASTM A992 (50 ksi minimum yield stress).

B. Miscellaneous structural steel, plates, etc. for pipe supports shall be ASTM A36 (36 ksi minimum yield stress).

C. Structural tubing shall be ASTM A500, Grade B (46 ksi minimum yield stress).

D. Welding of structural steel supports shall be completed with E70XX electrodes.

2.12 EXPANSION BOLTS

A. Expansion bolts and nuts used in connection with pipe support structures shall be stainless steel, Hilti "Kwik Bolt III" or approved equal by Powers or Red Head.

B. Embedment shall be as follows, unless noted otherwise:

Bolt Diameter, in.	Embedment, in.
1/2	3-1/2
5/8	4
3/4	4-3/4
1	6

2.13 ADHESIVE ANCHORS

A. Anchors for fastening to concrete shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge and 304SS anchor bolts with washer and nut, Hilti HIT HY200 with HIT-Z-R anchor bolt with minimum 6" embedment, or approved equal by Powers or Red Head.

B. Anchors for fastening to masonry shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge, 304SS screen tube (for hollow construction) and 304SS thread rod with washer and nut, Hilti HIT HY20 or approved equal by Powers or Red Head.

1. Pipe supports from masonry shall be installed only after review and approval by the Engineer.

PART 1 - EXECUTION

1.1 INSTALLATION

A. All piping shall be supported by suitable hangers to prevent excessive stress, swaying, sagging, or vibration.

B. Piping shall not be so restrained, however, as to cause it to snake or buckle between supports or anchors or to prevent movement due to expansion and contraction.

C. Hangers and supports shall be complete, including lock nuts, clamps, rods, bolts, couplings, swivels, inserts, required accessory items and secondary structural steel members.

D. Pipes shall be supported individually unless shown otherwise on drawings.

E. Provide supports, where pipe changes direction and at equipment connections.

F. Provide at least one hanger adjacent to each joint with mechanical couplings.

G. Weld pipe saddles to pipe.

H. Provide supplemental pipe support structural steel suitable for the applied loads as necessary to properly support all pipe.

1.2 SPACING

A. Unless otherwise shown on the Drawings the maximum spacing of supports for horizontal piping shall be as follows:

	Maximum Spacing, ft.	
Steel Pipe:	Steam, Liquids	Air & Gases
1/2”	5	6
3/4”	6	8
1”	7	9
1-1/4”	8	10
1-1/2”	9	11
2”	10	13
2-1/2”	11	14
3”	12	15
4”	14	17
6”	17	21
8”	19	24
10”	21	27
12”	23	30
16”	27	
18”	34	
24”	40	
Copper tubing:		
1” and under	5	
1-1/4”, 1-1/2”	7	
2” and above	10	
Cast Iron Pipe:		
6” and under	5 but not less than one support per pipe length	

B. Vertical pipe runs shall be supported and laterally braced at every floor level in multi-story structures and laterally braced only, at intervals not exceeding 15’ (10’ for 3” pipe and under) in other structures.

1.3 EXPANSION & ADHESIVE ANCHOR

A. Install in accordance with manufacturer’s instructions.

1.4 SEISMIC BRACING

A. Provide seismic (lateral and longitudinal) bracing for all piping with hanger length greater than 12” from the top of the pipe to the bottom of the support for the hanger.

B. Bracing shall be installed in such location and manner so as not to restrict thermal movement for hot piping.

C. Unless otherwise shown or approved, a pipe hanger used for lateral and longitudinal bracing shall include the following:

1. Clevis type hanger with pipe sleeve over horizontal through bolt.
2. 2 x 2 x 3/16 diagonal (1:1 slope) angle struts attached with bent clip angle to one side of hanger at through bolt. Weld or bolt other end of diagonal to support structure.

3. 2 x 2 x 3/16 angle to brace hanger rod for rods over 3' long. Weld angle to rod with 1/8" weld spaced 1" at 24" on center.

END OF SECTION 220529

SECTION 221313 – FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install sanitary sewers systems as shown on the Drawings and specified herein.

1.3 SUBMITTALS

A. Submit manufacturer's product data sheets.

1.4 QUALITY CONTROL

A. Plumbing systems shall comply with the requirements of the International National Plumbing Code (latest edition).

B. Cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute, unless approved otherwise by Engineer.

PART 2 - PRODUCTS

2.1 SANITARY DRAINS – BELOW GROUND

A. Pipe and fittings: Service weight, bell & spigot, cast iron, ASTM A74.

B. Joints: Neoprene compression gasket, push-on type, ASTM C564 and ASTM C1563.

2.2 SANITARY DRAINS & VENTS - ABOVE GROUND

A. Pipe and fittings: Cast iron, ASTM A888, no-hub, cast iron pipe system in accordance with CISPI 301.

B. Joints: Medium duty, stainless steel shield, clamp, and bolt assembly with neoprene gasket, in accordance with CISPI 310, ASTM C1540, and ASTM C564.

2.3 FLOOR DRAINS

A. Floor drains shall comply with ASME A112.6.3.

B. Type FD-1: Coated cast iron floor drain, with two-piece body, double drainage flange, non-puncturing flashing collar, weepholes, bottom outlet, 9" diameter, satin Nikaloy round strainer, 4" hub outlet. Josam No. 32100 Series, or equal.

C. Type FD-2: Coated cast iron floor drain, with two-piece body, non-puncturing flashing clamp collar, double drainage flange, weepholes, bottom outlet, round top, extra heavy-duty, loose-set grate, 14" diameter round grate, 4" no-hub spigot outlet or hub outlet with gasket. Josam No. 34710 Series, or equal.

2.4 CLEANOUTS

A. Cleanouts shall be installed as shown on the Drawings and specified herein.

B. Below Ground: Cleanouts shall be heavy duty, round coated cast iron access frame with heavy duty secured cover with screws and extra heavy, coated cast iron cleanout ferrule and raised head bronze plug.

1. Access frame shall be Neenah R-1976 or approved equal.

C. Ferrule and bronze plug shall be per ASTM A74, Standard Specification for Cast Iron Soil Pipe and Fittings.

2.5 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105.

1. Form: Sheet or tube.
2. Material: High-density, cross-laminated PE film of 0.004-inch minimum thickness.
3. Color: Black.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protection: Prior to excavating, Contractor shall contact all utility companies and have them mark all underground services in the construction area.

B. Contractor shall provide temporary supports for all underground utilities crossing an excavation.

C. Provide all required barricades, fencing, signs, lights, etc., as necessary for the protection of the workers and of the general public.

3.2 EXCAVATION, BEDDING AND BACKFILL

A. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work.

1. All necessary shoring and bracing shall be installed to insure worker safety and proper installation of mechanical work.
2. Provide all dewatering as required.
3. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only.
4. All trenches shall be open cut from the surface.

B. Bedding and Backfill: All underground piping shall be properly bedded and backfilled.

1. Bedding and backfill shall be sand or 3/4" minus crushed limestone with substantial quantity of fines or sand.
2. All bedding shall be laid on undisturbed soil.
3. If rock is encountered, excavate to a point 3” below installed bottom elevation of piping and provide bedding as called for above.
4. Backfill: Backfilling shall not begin until installation has been tested for leaks.

5. Take precautions to ensure that sewer line is not damaged due to the backfill material.
6. Placement: Place all material in lifts of 12" maximum compacted to 95% of maximum dry density as determined by ASTM D1557.
7. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.

C. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site by the Contractor, unless approved otherwise by Construction Representative.

D. Provide caution tape 12" above the top of the buried sewer system. Tape shall be 6" wide, black in color with "Sewer" labeled on the tape in white lettering.

E. Restoration of Existing Conditions: Final surface and adjacent disturbed areas shall be restored to match the original condition by sodding, seeding, asphalt paving, concrete, etc., as required.

3.3 INSTALLATION

A. Installation of cast iron soil pipe shall conform to the International Plumbing Code and to the procedures specified in the Cast Iron Soil Pipe Institute's specifications and CISPI's "Cast Iron Soil Pipe and Fittings Handbook", latest edition.

B. Piping shall be supported at couplings, changes in direction or line size, and on no more than 5 foot centers.

C. Piping shall be braced or anchored at branches and direction changes to prevent swaying, horizontal movements, joint separation, sagging, over stress, etc.

D. Seismically brace pipe in accordance with the building code.

E. Drain and vent risers shall be laterally braced at couplings.

F. Make changes in direction using appropriate branches, bends, and long-sweep bends.

G. Do not make change in direction of flow greater than 90 degrees.

H. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

I. Straight tees, elbows, and crosses may be used on vent lines only.

J. Use proper size of standard increasers and reducers if different sizes of piping are connected.

K. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drain piping beginning at low point of each system.

M. Install true to grades and alignment indicated, with unbroken continuity of invert.

N. Place hub ends of piping upstream.

O. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

P. Install horizontal drainage piping with slope noted on Drawings.

Q. Install horizontal vent piping without pockets and with minimum 1 percent slope to drain.

R. Use transition fittings to join dissimilar piping materials.

S. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:

1. Cast-iron pipe and fittings.
2. Special pipe fittings.

T. Floor drains shall be set ¼" below the normal finished floor elevation unless otherwise shown on the Drawings.

U. Cleanouts: Apply Teflon paste thread lubricant to male threads of all cleanout plugs.

3.4 PIPE SUPPORTS

A. Pipe supports and seismic bracing shall be as specified in Section 220529, "Hangers and Supports for Plumbing".

3.5 PROTECTION

A. Protect drains during construction to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.6 TESTING

A. Leak testing of all plumbing systems installed under this section shall be performed only after due notice to and in the presence of the Owner's Representative and local authorities having jurisdiction.

B. Testing shall comply with International Plumbing Code.

C. System should be properly restrained at all bends, direction changes, and end of runs during leakage testing.

D. Testing and inspection of concealed work shall be completed prior to covering.

3.7 CLEANING

A. Maintain swab in piping and pull past each joint as completed

B. Clean interior of piping system. Remove dirt and debris as work progresses.

END OF SECTION 221313

SECTION 230501 – GENERAL MECHANICAL REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The requirements of this section are applicable to all work performed under Division 23 – Heating, Ventilating, and Air Conditioning (HVAC).

1.3 COORDINATION

A. It is the intent of the Mechanical Division of these Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations shall operate as designed.

B. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's Representative.

C. The Contractor shall note that piping, ductwork and equipment as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference free systems with proper clearance to facilities and equipment.

D. The Contractor shall note that configuration and dimensions of equipment may vary from that shown on the Drawings depending on the equipment supplied. The Contractor shall be responsible for making the necessary modifications to connecting piping, ducts, bases, etc. required by the equipment supplied.

E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

1.4 SUBMITTALS

A. Submittals shall be furnished under this Division for approval in accordance with the procedures outlined in Division 1 and the separate sections of this Division.

B. Submittals shall include complete data including physical dimensions and other information required for installation as well as performance capabilities and limitations. Provide schedules indicating locations when more than one type of an item is to be used. All shop drawings must be certified as being correct for the proposed work.

C. Shop drawings, brochures or catalog cuts showing more than one size or model shall be marked to indicate the size or model proposed for the particular application.

D. Prior to submitting for approval, submittals shall be coordinated with the work of all other trades.

E. Submittals shall be identified as to the specific equipment for which the submittal relates. Identification shall be by reference to equipment numbers as shown on the Drawing or by

reference to the appropriate Article of the Specifications in which the equipment is specified.

1.5 INSTRUCTION MANUALS

A. Instruction manuals shall be furnished to Owner's Representative prior to start-up. Manuals shall be bound with table of contents and tabs for each section. Each set is to include the following information for all equipment furnished:

1. Manufacturer's parts list identified with the make, model and serial number of the equipment furnished.
2. Schematic control, flow and wiring diagrams identifying the location and function of all system components, valves and controls.
3. Installation, operation, lubrication and maintenance instructions.
4. Manuals shall incorporate design basis, drawings, flow diagrams, brochures and operating instruction in sufficient detail to enable operators to understand the equipment or system, its operation, limitations and maintenance needs.

1.6 CODES AND STANDARDS

A. Governing federal, state and local laws, codes and standards constitute minimum requirements and strict compliance therewith is required unless supplemented and/or modified by more stringent requirements of the Contract Documents.

B. Installation of HVAC systems and equipment shall comply with all applicable codes. These shall include the latest edition of the following:

1. International Mechanical Code
2. International Plumbing Code

C. All equipment, apparatus and systems shall be fabricated and installed in complete accordance with the latest edition or revision of the following applicable regulations, standards and codes:

1. ANSI - American National Standards Institute
2. ARI - Air Conditioning and Refrigeration Institute
3. AABC - American Air Balance Council
4. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
5. ASME - American Society of Mechanical Engineers
6. ASSE - American Society of Sanitary Engineering
7. ASTM - American Society for Testing and Material
8. AMCA - Air Moving and Conditioning Association
9. AWS - American Welding Society
10. BOCA - Building Officials and Code Administrators
11. NFPA - National Fire Protection Association

12. IMC - International Mechanical Code
13. IPC - International Plumbing Code
14. NEC - National Electrical Code
15. NEMA - National Electric Manufacturers Association
16. NSF - National Sanitation Foundation
17. PDI - Plumbing and Drainage Institute
18. OSHA - Occupational Safety and Health Administration
19. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
20. UL - Underwriters Laboratories, Inc.

1.7 QUALITY STANDARDS

A. All materials and equipment furnished under these Specifications shall be new and to the extent possible, standard products of the various manufacturers except where special construction or performance features are called for. Where more than one of the specific items is required, all shall be of the same type and manufacture.

B. The product of manufacturers shall be acceptable only when that product complies with or is modified as necessary to comply with all specified and indicated requirements in the Contract Documents.

C. Materials and equipment not herein specified or indicated as to manufacture but necessary for complete functioning systems shall be provided from sources conforming to the quality levels and functional requirements for corresponding materials and equipment set forth herein.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. All equipment shall have factory applied permanent nameplates indicating the manufacturer's name, model and serial numbers, temperature and pressure design and any other data necessary to conform with specified requirements.

2.2 LIFTING ATTACHMENTS

A. All equipment requiring hoisting for installation and/or maintenance shall be provided with suitable lifting attachments by the manufacturer. Manufacturer's installation instructions shall detail correct lifting procedures to preclude equipment damage.

2.3 EQUIPMENT GUARDS

A. All rotating equipment including couplings, gear trains and belt drives shall be provided with adequate guards for personnel protection. Wherever possible, the guards shall be provided by the equipment manufacturer. The guards shall be supported to prevent vibration or interference with the rotating equipment and shall be removable. Guards shall conform to OSHA requirements.

2.4 EQUIPMENT PROTECTION

A. Equipment openings and connections shall be provided with adequate covers at the factory to protect the internals, threads and flanges and prevent entrance of any foreign matter prior to installation.

B. Exposed machined surfaces of equipment such as shafts, bearing surfaces, gasket surfaces, gears, etc., shall be provided with adequate protection at the factory to prevent physical damage and corrosion prior to installation.

2.5 PAINTING AND FINISHES

A. All purchased equipment shall have a factory applied standard finish of the manufacturer's standard color unless otherwise specified.

B. Finishes which are marred during shipping, handling or installation shall be touched up to match the original finish.

C. Field fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed, be thoroughly cleaned of dirt, rust, weld slag, grease or oil.

D. Comply with Division 09 requirements regarding paints and finishes.

1. Subject to approval of Construction Representative, small field-fabricated bare iron or steel items such as small pipe support members may be painted with one prime coat of rust inhibiting primer.

2.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with the manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by the Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's Representative prior to final acceptance of the equipment.

2.7 GROUT

A. Unless otherwise required by the equipment manufacturer, grout shall be non-metallic, non-shrink type, with 5000 psi compressive strength at 28 days.

PART 3 - EXECUTION

3.1 WORK VERIFICATION AND FIELD MEASUREMENTS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. Location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Owner's Representative shall be notified and any changes approved before proceeding with the work.

3.2 PERMITS AND INSPECTIONS

A. Contractor shall be responsible for obtaining the required permits governing the work from authorities having jurisdiction and shall assume the cost of permits and inspections.

B. Upon completion of work, Contractor shall furnish to the Owner certificates of inspection or approval from the authorities having jurisdiction, if certificates of inspection or approval are required by law or regulations.

3.3 RECORD DRAWINGS

A. Contractor shall keep a written record of all deviations in location or elevation of piping and any underground or concealed installation from that shown on the Drawings. Records shall consist of clearly marked Drawings which shall be submitted to the Engineer after completion of construction.

B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or bench mark. Utility services outside of buildings shall also show depth of burial or flow line with reference to the finished ground floor elevation.

3.4 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.5 FASTENING TO BUILDING STRUCTURES

A. The methods of attaching or fastening equipment or equipment supports or hangers to the building structure shall be subject to approval by the Owner's Representative at all times.

B. Cutting, burning, drilling, welding or the use of explosive driven fasteners on building structures shall require prior approval by the Owner's Representative for each type of application unless specifically shown on the Drawings.

C. Equipment or piping shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions unless specifically indicated on the Drawings.

3.6 THERMAL METAL JOINING AND CUTTING

A. All welding, brazing, soldering and cutting work shall conform to applicable provisions of the following codes and requirements:

1. ASME Boiler and Pressure Vessel Code
2. American National Standards Institute (ANSI) B31.1 (latest), Power Piping, and Addenda
3. American Welding Society (AWS) D1.1 (latest) Structural Welding Code

B. Welding shall be performed only by skilled welders.

C. Welders and welding procedures employed on pressure vessel or pressure piping work performed under the ASME/ANSI code shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code or with local codes where they take precedence. A record shall be maintained on the job showing the date and results of qualification test for each welder employed on the job for code welding. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner.

D. Welders and welding procedures employed on structural steel pipe and equipment supports shall be qualified by tests in the "Standard Qualification Procedure" of the AWS.

E. A record shall be maintained on the job showing the date and results of qualification test for each welder employed on the job.

F. Qualified weld procedures and one certified copy of the qualification test for each welder so employed shall be furnished to the Owner's Representative.

G. Welding electrode storage shall, at a minimum, comply with the requirements of AWS D1.1, ANSI B31.1, ASME Boiler and Pressure Vessel Code, or the electrode manufacturer, whichever is most stringent.

H. Contractor shall establish the proper quality control procedures and tests to insure that all welds comply with the applicable requirements of the codes referenced above.

I. The Contractor shall test all pipe welds for proper quality using nondestructive, ultrasonic testing procedures.

1. Testing shall be completed by Contractor’s third party, certified weld inspector.

J. Contractor shall complete any required repairs at Contractor’s cost.

K. All cutting residue shall be cleaned from the interior of pipes prior to welding or joining.

3.7 HOUSEKEEPING PADS AND ANCHOR BOLTS

A. Housekeeping pads shall be provided for all floor-mounted equipment. Unless otherwise shown, housekeeping pads shall be 4" high, 4000 psi concrete, with #4 reinforcing rods 12" on center each direction in center of pad.

B. The size and configuration of housekeeping pads and anchor bolt requirements shall be coordinated with and shall be suitable for the equipment to be installed. Contractor shall be responsible for coordinating all requirements prior to forming and pouring the pad.

C. Existing floor surface shall be roughened or epoxy binder applied prior to pouring pad. Pad shall be doweled to existing concrete with #4 reinforcing rods located 3" inside pad perimeter on 12" centers.

D. Anchor bolts and sleeves shall be furnished for equipment provided under this Division to suit the equipment.

3.8 GROUTING

A. All mechanical equipment and pipe supports sitting on concrete shall be properly shimmed with stainless steel metal shims and grouted.

B. Grout shall be placed to completely fill the area between the equipment and the concrete.

C. Hollow equipment frames shall be completely filled with grout if recommended by the equipment manufacturer.

3.9 CUTTING AND PATCHING

A. All required openings shall be cut by the Contractor.

B. Under no circumstances shall any structural members, loadbearing walls or footings be cut without first obtaining written permission from the Engineer and Owner's Representative.

C. Cutting shall be in accordance with the following.

1. Concrete or Masonry: All openings for pipe in concrete or masonry materials shall be core drilled. Square or rectangular openings shall be saw cut as necessary.

2. Grating and Floor Plate: Openings in grating and steel floor plate shall be neatly cut without irregular edges.

3. Roofing: All penetrations of roofing shall be made in strict accordance with manufacturer's recommended details so as not to void warranty.

D. Patching shall be in accordance with the following.

1. Concrete or Masonry: Install sleeves for piping penetrations in accordance with Section 232000. Patch the opening with grout finished smooth with adjacent surface.

2. Grating: All openings cut in grating shall be banded.

E. All below grade openings for pipe shall be sealed with interlocking synthetic rubber link assembly, Link-Seal by Thunderline Corporation or equal.

3.10 START-UP AND TESTS

A. The Contractor shall start-up the mechanical systems with his own personnel after obtaining approval for start-up from Owner’s Representative. Owner's personnel shall be in attendance.

B. The Contractor's performance of the start-up shall not constitute acceptance. The Work shall remain the responsibility of the Contractor until final acceptance.

C. Any equipment or system placed in temporary operation for testing or for the convenience of Contractor during construction and before Owner takes over operation shall be properly operated and maintained by Contractor.

D. All equipment and systems shall be protected against freezing, flooding, corrosion or other form of damage prior to acceptance by the Owner.

E. Material or equipment damaged, shown to be defective, or not in accordance with the Specifications, shall be repaired or replaced to the satisfaction of Owner's Representative.

F. Before starting up any system, each piece of equipment comprising a part of the system, shall be checked for proper lubrication, drive rotation, belt tension, continuity of controls, and any other condition which may cause damage to equipment or endanger personnel.

G. Contractor shall provide a competent service representative trained in starting up and servicing the respective equipment for which he is responsible. Service representative shall be present to supervise the start-up of equipment and/or systems and training the Owner's personnel.

H. Test runs shall be made over the full design load range when possible, or simulated to the satisfaction of Owner's Representative for other conditions. Tests shall continue for as long as necessary to demonstrate that systems will operate as designed.

I. During start-up all necessary adjustments shall be made, controls checked for proper operation, motors checked for possible overload, and the entire system checked by Contractor for any abnormal condition.

J. During the start-up and prior to acceptance of any system, Owner's designated operating personnel shall be instructed in the operation and maintenance of the system.

K. After start-up has been concluded and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipe line strainers and filters shall be cleaned, air filters cleaned or replaced, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required. Temporary piping, ducting, wiring, instrument connections, etc., shall be removed, and openings restored in a permanent manner acceptable to Owner's Representative.

L. All tests shall be made after notification to and in the presence of the Owner's Representative and the authorities having jurisdiction.

END OF SECTION 230501

SECTION 230505 – SELECTIVE DEMOLITION FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment and services necessary to perform all demolition work.

B. Work included in this Section includes all demolition work as shown on the Drawings and as specified herein and as required to complete the Work.

1.3 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity and interruption of utility services.

B. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finished surfaces, which might be misconstrued as damage caused by selective demolition operations.

C. Disposal Records: If hazardous wastes are removed by contractor, submit the following:

1. Hazardous Waste Transporter license
2. Permit or license for hazardous waste treatment or disposal facilities
3. Completed Uniform Hazardous Waste Manifest for all shipments

1.4 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

D. Prior to beginning demolition, arrange a conference with the Owner’s Representative to review demolition scope, procedures, schedule and items to be salvaged for the owner.

1. The Owner retains the right of first refusal on all items shown to be removed by the Contractor.

1.5 PROJECT CONDITIONS

A. Owner will occupy site and buildings immediately adjacent to selective demolition areas. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Owner's Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection and life safety facilities in service during selective demolition operations.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.7 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and coordinate and identify the extent of the demolition work required. Record existing conditions using preconstruction photographs.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

D. When unanticipated site, mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner's Representative and Engineer.

E. Engage a professional engineer to survey conditions of existing structures to determine whether excavations or the removal of any element might result in structural deficiency or unplanned collapse of any portion of existing structures during selective demolition operations.

F. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

A. No demolition work shall be performed without prior approval of the Owner's Representative.

B. Demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.

C. Any demolition work which interferes with Owner's operation shall be scheduled with the Owner's Representative and be subject to the Owner's approval.

D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.

E. Do not interrupt existing utilities serving occupied facilities except when authorized in writing by the Owner and authorities having jurisdiction.

F. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

G. Unless noted otherwise, provide not less than two weeks' notice to the Owner if shutdown of service is required during the execution of the work.

H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Owner's Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. Existing building openings may be used to remove material. No new openings may be made without approval of the Owner's Representative.

3.4 PROTECTION

A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during demolition operations.

B. Comply with the International Fire Code including the requirements for fire safety during demolition and construction and for welding and other hot work.

1. Maintain a hot work program permit system, including fire watch.
2. Maintain portable fire-suppression devices in work areas.
3. Minimize hot work within occupied buildings.

C. Provide dust control and ventilation as required in areas of demolition.

D. Execute demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas; maintain free and safe passage of persons around the areas of demolition.

E. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the demolition work.

F. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.

G. Protect existing surfaces, active utility services, and equipment which are to remain in place.

H. No blasting will be permitted.

3.5 DUST CONTROL

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's property.

B. Adequacy of the dust control methods shall be subject to the approval of the Owner's Representative.

C. Areas of major demolition inside the Owner's property shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.

D. Temporary enclosures shall be removed by the Contractor upon completion of the demolition work unless otherwise directed by the Owner's Representative.

3.6 DEMOLITION - GENERAL

A. Remove all work indicated on the drawings and as required to complete the new work indicated.

B. During demolition operations, keep areas adjacent to demolition work free of dust and debris.

C. During demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Owner’s Representative.

D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting demolition operations.

E. Neatly cut openings and holes plumb, square and true to dimensions, required.

F. Use cutting methods least likely to damage construction to remain or adjoining construction.

G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

I. Do not use cutting torches until work area is cleared of flammable materials.

J. Maintain portable fire-suppression devices in the area during flame-cutting operations.

K. Contractor shall take care when using a torch to cut steel welded or bolted to structural members so as to cut flush with but not damage the structural members.

L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.

M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.

N. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

O. Dispose of demolished items and materials promptly.

3.7 CONCRETE AND MASONRY DEMOLITION

A. Demolish concrete and masonry in small sections.

B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

C. Sidewalks, curbs, gutters and pavement shall be neatly saw cut at existing joints where removal is required for new construction.

3.8 PIPING DEMOLITION

A. The Contractor shall use caution in the demolition of piping and shall inform himself of the conditions (fluid, pressure, temperature) of all piping systems to be demolished before making any cuts or breaking any joints.

B. Prior to breaking or cutting piping or tubing within the demolition area, the Contractor shall ascertain that the system has been marked in the field or shown on the Drawings to be removed under this contract. Contact Owner's Representative for clarification prior to demolishing or removing questionable items.

C. Arrange for shutoff, isolation, and lock-out of piping with Owner’s Representative or utility companies.

D. When indicated on the drawings, before proceeding with selective demolition, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems.

E. All remaining piping with open ends resulting from demolition work shall be promptly capped, plugged or blind flanged.

3.9 PATCHING

A. All holes or openings in floors, walls or ceilings resulting from demolition shall be properly sealed with material similar to the adjacent surface/finish.

B. All rough edges of openings created by demolition shall be promptly patched to create a finished surface.

C. Openings in concrete shall be patched with cement mortar.

D. Openings in masonry shall be patched by toothing in masonry units to match existing.

3.10 REMOVED AND SALVAGED ITEMS

A. Carefully remove and clean salvaged items.

B. Pack or crate items after cleaning. Identify contents of containers.

C. Store items in a secure area until delivery to Owner.

D. Transport items to Owner's storage area as directed by Owner's Representative.

E. Protect items from damage during transport and storage.

3.11 REMOVED AND REINSTALLED ITEMS

A. Carefully remove items to be reinstalled.

B. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

C. Pack or crate items after cleaning and repairing. Identify contents of containers.

D. Protect items from damage during transport and storage.

E. Reinstall items in locations indicated.

F. Comply with installation requirements for new materials and equipment.

G. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

H. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

3.12 EXISTING ITEMS TO REMAIN

A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

B. When permitted by Owner's Representative, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.13 DISPOSAL

A. All debris resulting from demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Owner's Representative.

B. Storage of removed materials on site will not be permitted.

C. Sale of removed materials on-site will not be permitted.

D. Transport demolished materials off Owner’s property and dispose of legally in accordance with Federal, State, and local laws and regulations.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.14 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.

B. Return adjacent areas to condition existing before selective demolition operations began.

3.15 HAZARDOUS MATERIALS

A. The Owner, to the best of his knowledge, has identified hazardous materials, including friable asbestos, in the items to be demolished or the work areas.

B. Should the Contractor discover material requiring removal which is suspected to contain hazardous materials, do not disturb.

C. Contact and consult with the Owner's Representative prior to proceeding. The Owner's Representative shall direct the Contractor how to proceed.

END OF SECTION 230505

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This specification section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers
2. Torque, speed, and horsepower requirements of the load
3. Ratings and characteristics of supply circuit and required control sequence
4. Ambient and environmental conditions of installation location

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 (latest edition) unless otherwise indicated.

B. Comply with IEEE 841 (latest edition) for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor

B. Efficiency: NEMA Premium Efficient, as defined in NEMA MG 1

C. Service Factor: 1.15

D. Multispeed Motors: Variable torque

1. For motors with 2:1 speed ratio: Consequent pole, single winding

2. For motors with other than 2:1 speed ratio: Separate winding for each speed

E. Multispeed Motors: Separate winding for each speed

F. Rotor: Random-wound, squirrel cage

G. Bearings: Regreasable, shielded, antifriction ball or roller bearings suitable for radial and thrust loading. Minimum AFBMA L10.

H. Temperature Rise: Class B

I. Insulation: Class F

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic

K. Enclosure: Totally enclosed fan cooled (TEFC), cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T unless otherwise indicated in specifications.

L. Voltage and Speed: As indicated in the equipment schedule on the Drawings.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with vacuum pressure impregnated or inverter grade insulation system that meets the requirements of Section I, Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors" of MEMA MG1 designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

5. Motor Shaft Grounding Device: Provide a shaft grounding device for protection of the motor bearings from electrical discharge machining caused by capacitive induced shaft voltage discharging through the motor bearings. The grounding device shall have field replaceable silver graphite or carbon brush(es) with compression spring and brass holder/housing. The grounding device shall be factory mounted on the motor shaft or non-drive end of the motor, external to the motor housing. Shaft grounding ring type devices that utilize multiple carbon wires all around are not acceptable. The brush(es) must be field maintainable and replaceable without any motor disassembly or decoupling the motor shaft

from the driven load. Shaft grounding device shall be Helwig Carbon Products Model BPK, Shaft Grounding Systems CR Series or approved equal by Emerson Bearing or provide insulated (ceramic) bearings at both the drive and fan end of the motor. The shaft grounding device can be mounted on the drive end of the motor only if it will be maintainable and replaceable without decoupling the motor from the pump. Otherwise, mount on fan end of motor.

C. Motors operated at frequencies greater than name plate rating: For direct drive equipment with top speed listed higher than nominal motor speed, motor shall be capable to operate at scheduled frequency on a continuous basis.

D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor
2. Split phase
3. Capacitor start, inductor run
4. Capacitor start, capacitor run

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading

D. Motors 1/20 HP and Smaller: Shaded-pole type

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230515 – VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 Specification Sections apply to this Section.

1.2 SCOPE

A. This specification section applies to variable-frequency drive (VFD) alternating current motor controllers provided by:

1. The reverse osmosis water treatment equipment supplier in accordance with Section 232519.16 – Reverse Osmosis Water Treatment Equipment.
2. The reverse osmosis water pumping system equipment supplier in accordance with Section 232519.40 – Reverse Osmosis Water Pumping System.

1.3 RELATED SECTIONS

A. Section 230513 – Common Motor Requirements for HVAC Equipment

B. Section 230501 – General Mechanical Requirements for HVAC

C. Section 260500 – Common Work Results for Electrical

D. Section 260553 – Identification for Electrical Systems

E. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

F. Section 260583 – Wiring Connections

G. Section 282813 – Fuses

1.4 SYSTEM DESCRIPTION

A. Provide UL Listed and Labeled variable-frequency drives as specified herein. The drive power unit shall be factory-assembled, tested and programmed. Assembly of drive and all specified components in the specified hinged door enclosure may be performed in the UL508 certified panel shop of a factory authorized representative or distributor for the drives.

B. Each VFD shall be a pulse width modulated (PWM) variable-frequency alternating current motor control assembly that is horsepower rated and capable of controlling the specified motor and load in accordance with this Specification.

C. Provide VFDs listed and labeled as a complete unit and arranged to provide variable speed of a standard NEMA Design B, 3-phase, induction motor serving a variable torque load by adjusting output voltage and frequency of VFD. VFD shall be designed and rated by the manufacturer for the type of load (e.g., fans, blowers, and pumps) with which used. All VFD control circuitry shall be digital.

D. The VFDs shall be designed to provide for ease of maintenance.

1.5 SUBMITTALS

A. Manufacturer's product data sheets and shop drawings for VFDs indicating compliance with these specifications and VFD efficiency from power connection to motor (in order to take into account all filter and reactor losses) shall be submitted for approval.

B. Shop drawings shall also include, but not be limited to, the following:

1. Outline drawing, showing overall dimensions, conduit locations, and weight of assembly
2. Schematic diagrams including three-line motor control schematic
3. Internal wiring diagrams
4. External (interconnecting) wiring diagrams showing how all items are to be connected together
5. General arrangement, showing exterior and interior component layouts
6. Complete Bill of Material of all items, listing items by quantity, description and manufacturer's catalog number
7. Installation details

C. Certified test reports indicating compliance with specified performance requirements

D. Provide a letter from the manufacturer certifying that the VFD is suitable for use on a 480 volt, 3-phase, 3-wire corner grounded delta ("grounded B-Phase") power system.

E. Shop drawings shall be conformed to "as-built" status by incorporating any and all changes made during the startup period.

F. Submit Instruction Manuals in accordance with Section 007213 - General Conditions, Article 3.5 – Operation and Maintenance Manuals.

1. Instruction Manuals shall include programming, installation details, operation and maintenance instructions, and a replacement parts list.

1.6 LISTING AND LABELING

A. Provide products specified in this Section that are listed and labeled for the specific purpose by Underwriter's Laboratories and comply with the applicable NEMA standards.

1. NEMA Compliance: NEMA ICS 7, "Adjustable Speed Drives"
2. UL Compliance: UL 508C, "Power Conversion Equipment."

B. Single-Source Responsibility: Obtain all VFDs from a single manufacturer.

1.7 WARRANTY

A. *General Requirements*: Provide, at no additional cost to the Owner, all services, materials and equipment necessary for the successful operation of the entire system for a period of two full years. Provide necessary material required for the work. Minimize impacts on facility operations when performing scheduled adjustments and non-scheduled work.

B. *Description of Work*: The adjustment and repair of the system includes all computer equipment, software and firmware updates, transmission equipment and all sensors and control devices. Provide the manufacturer's required adjustments and all other work necessary within the specified warranty period.

C. *Personnel*: Provide qualified personnel to accomplish all work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

D. *Emergency Service*: Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. Furnish Owner with a telephone number where service representative can be reached at all times. Service personnel shall be at the site within 4 hours after receiving a request for service. Restore the control system to proper operating condition within 3 days.

E. *Operating*: Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the initial performance test.

F. *Systems Modifications*: Provide any recommendations for system modification in writing to Owner. Do not make any system modifications, including operating parameters and control settings, without prior approval of Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

G. *Software and Firmware*: Provide all software updates and firmware and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and shall be incorporated into the operations and maintenance manuals, and software documentation.

PART 2 - PRODUCTS

2.1 MOTOR DATA

A. Each VFD shall drive a new MG 1, Section IV, Part 31 compliant motor meeting the requirements of Section 230513 – Common Motor Requirements for HVAC Equipment.

B. Motor characteristics; voltage, number of phases, horsepower, etc. for each application shall be as indicated in the motor control schedule on the Drawings.

2.2 VARIABLE FREQUENCY MOTOR CONTROLLERS

A. Each VFD shall convert 480 volts AC, 3-phase, 3-wire, 60 hertz power to an adjustable AC frequency and voltage for controlling the speed of an AC squirrel cage induction motor. **VFDs shall be suitable for connection to a 480 volt, 3-phase, 3-wire corner grounded delta ("grounded B-Phase") power system. The UL Listing of the drive shall not be voided by use on a grounded B-phase power system.** Provide any necessary modifications to the drive that are required to provide proper operation when connected to a grounded B-Phase power system. Any modifications that are intended to be made in the field must be clearly indicated in the installation, operation and maintenance manual for the drive.

B. *Input Voltage and Frequency Tolerance*: The VFDs shall require no external control power and shall have a voltage tolerance of ± 10% and a frequency tolerance of ±2 Hz.

C. The controller shall include power conversion components, power control logic devices and regulator circuitry. The regulator shall be fully digital with microprocessor control of frequency, voltage, and current. Microprocessor memory shall be non-volatile.

D. *AC to DC Converter (Rectifier)*: Only full-wave AC to DC converters shall be used. No converters which require a power system neutral connection shall be used.

E. *DC to AC Converters (Inverters)*: Inverters shall be rated for continuous duty in a 50°C ambient environment, using the motor full load currents listed in NEC Table 430-250, over the full range of possible carrier frequencies. Upsize VFDs if/as required to account for output derating when operated in a 50°C ambient environment. Main semiconductors shall be Insulated Gate Bipolar Transistors (IGBT). Each inverter power electronics component (e.g., IGBT) shall have a minimum DC breakdown rating of at least 150 percent of the DC bus voltage.

F. Characteristics of the VFDs shall be as follows:

1. *Output Rating*: 3-phase, 480 volts. The control scheme shall closely approximate actual sine wave current throughout the speed range and shall not cause notching of the input line.
2. *Output frequency range*: 6 Hz to 90 Hz minimum.
3. *Frequency resolution/*accuracy: Frequency resolution shall be 0.01 Hz digital to 0.1 Hz analog with an accuracy of ±0.01% of maximum frequency for the digital input and ±0.2% of maximum frequency for the analog input at 25°C ±10°C.
4. Voltage shall be proportional to frequency up to 60 Hz; voltage shall not exceed 528 volts at frequencies above 60 Hz. The frequency at maximum voltage shall be adjustable from 25 Hz to 90 Hz.
5. Voltage boost during motor starting shall be adjustable from 0% to 30% with starting frequency adjustable over the range of 1 Hz to 10 Hz or wider.
6. *Frequency setting signal*: Setting dial on front panel of drive
7. *Speed Regulation*: Plus or minus 3% in PWM mode
8. Ambient Operating Temperature: 0°C to 50°C. Upsize VFDs if/as required to account for output derating when operated in a 50°C ambient environment.
9. *Relative Humidity*: 5% to 93%, non-condensing
10. *Efficiency*: 95% minimum through full operating range
11. *Power Factor*: 95% throughout the load and speed range
12. *Output Overcurrent Rating*: 100% of drive nameplate rating continuously, 100% of the NEC Table 430.250 full load amps for all motors controlled by the drive continuously, and 110% of drive nameplate rating for one (1) minute with automatic stall prevention and voltage boost to prevent nuisance tripping during load or line side transient conditions
13. *Output Power Rating*: As required to operate the pump motors indicated in the motor control schedule on the Drawings under the conditions at the project site.
14. *PWM Carrier Frequency*: Adjustable from 2,000 Hz to 8,000 Hz minimum. Upsize VFDs if/as required to account for output derating when the carrier frequency is set to 8 kHz.

G. Isolated control interfaces to allow the VFD to follow the following electrical signals over full speed range:

1. 4 to 20 mA DC, floating connection
2. 0-10 volts DC

H. *Internal Adjustability*: Provide the following internal adjustment capabilities:

1. *Speed*: 0 to 100% of maximum RPM
2. *Acceleration*: .1 to 6000 seconds with choice of linear, S or C curves
3. *Deceleration*: .1 to 6000 seconds with choice of linear, S or C curves
4. *Current Limit*: 50% to 110% of maximum rating continuous
5. Standard Dynamic Electric Braking

6. Electronic Overload Protection: UL Listed, 10% to 100%
7. *Soft Stall*: 10% to 150%

I. Self-protection and reliability features shall include:

1. *Integral Main Disconnect*: For disconnection of all power to the VFD. Interlock main disconnect with VFD enclosure door so that the main disconnect must be opened before the door can be opened. An interlock override device shall be provided to allow authorized personnel to release the interlock and open the enclosure door for inspection purposes when the main disconnect switch is in the ON or CLOSED position. The switch handle shall have provisions for padlocking on the OFF position. Line side overcurrent protection shall be provided, either a molded case thermal magnetic circuit breaker or UL Class J fusing as required for an integrated device short circuit withstand rating of 14,000 RMS symmetrical amperes at 480 VAC. Fuses shall meet the requirements of Section 262813 – Fuses. Provide solid copper ("dummy fuse") in the B-Phase fuse clips. Do not order any VFDs until the required short-circuit current ratings for each VFD have been determined in accordance with Section 260573 – Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment. Through-the-door type disconnect switch, with extension rod and door mounted operator, will be acceptable only if the extension rod does not exceed 4-inches in total length. Otherwise, provide flange mounted type disconnect switch with cable operator.
2. *Input Transient Protection*: Protection for a Category B, medium exposure environment, as defined by ANSI C62.41 - IEEE Recommended practice on Surge Voltages in Low-Voltage AC Power Circuits.
3. Snubber networks to protect against malfunction due to system voltage transients.
4. *Critical Speed Bypass*: Provide a minimum of 3 adjustable, field selectable, critical frequency bypass settings with individual bandwidth to prevent operation of the VFD-motor-load combination at a natural frequency of the combination. Upper and lower frequency limits shall be capable of being varied.
5. *Cooling Fans*: Provide cooling fan(s) for drive enclosure if/as required to keep the maximum temperature within the drive enclosure within manufacturer's and specified tolerances for operation in a 50°C ambient environment. Provide automatic cooling fan control based on heat sink temperature for extended fan life.
6. Reverse Phase Protection or ability to properly operate with both ABC and CBA Phase Rotation on Input Power
7. Phase Loss Protection
8. Short Circuit Protection
9. *Lockout*: Provide input to lockout VFD upon receipt of momentary external contact opening. Lockout must not automatically reset; it shall be resettable only by manual means at the VFD.
10. The drive shall have external fault input.
11. The drive shall be capable of re-setting faults remotely and locally.
12. The drive shall be programmable to alert the following alarms and status:

    a. Over torque
    b. Inverter overload
    c. Motor overload
    d. Inverter overheat
    e. Undercurrent
    f. Overcurrent
    g. Over speed
    h. Over voltage
    i. Restart

j. Communication error alarm
k. Executing retry

13. The drive shall identify and display the following faults:

a. Sink/Source Error
b. Encoder Error
c. Overspeed
d. EEPROM Error
e. Open DC Fuse
f. Input Line Loss
g. Output Line Loss
h. Main RAM Fault
i. Main ROM Fault
j. CPU Fault
k. Communication Interrupt Fault
l. Option Device Fault
m. Main Circuit Undervoltage
n. Overcurrent (Acceleration)
o. Overcurrent (Deceleration)
p. Overcurrent RUN
q. A Phase Short Circuit
r. B Phase Short Circuit
s. C Phase Short Circuit
t. Motor Overcurrent
u. Overheat
v. VFD Overload
w. Motor Overload
x. Overvoltage (Acceleration)
y. Overvoltage (Deceleration)
z. Overvoltage (Run)
aa. Control Circuit Undervoltage
bb. Communication Error
cc. Undertorque
dd. Low Current
ee. Undervoltage Trip Main Circuit
ff. Undervoltage Trip Control Circuit

J. Monitoring functions shall include:

1. The drive digital display shall be 2-line LED or backlighted LCD, minimum of 14 characters per line.
2. The drive digital display shall be capable of displaying: output frequency, % current, output current amps, % voltage in and out, voltage in volts in and out, RPM, input and output Watts, torque, and input reference signal.
3. The drive's programmable parameters shall be capable of being changed while the drive is operating, with the exception of those the manufacturer deems should not be for safety reasons.
4. The drive's parameters shall be adjustable from the key touchpad or computer link.
5. The drive's key touchpad shall have a minimum rating of NEMA Type 4 and shall be mounted in the door of the enclosure for the drive such that it is accessible externally, without opening the enclosure door. A cutout in the door of the drive enclosure that allows

the drive mounted operator interface panel to extend through the front of the enclosure when the door is closed does not meet the intent of this requirement.

6. The drive shall contain a reset of all parameters to factory default settings or user defaults (whichever one is chosen).
7. The drive shall have 2 programmable analog outputs.
8. The drive shall have 3 programmable relay outputs.
9. The drive shall have 8 programmable discrete inputs.
10. The drive shall have a pulse train output proportional to frequency.
11. The drive shall have an elapsed time meter.

K. *Automatic Reset/Restart*: Attempt up to at least 5 restarts (user selectable) after VFD fault or on return of power to the system following an interruption and before shutting down for manual reset or fault correction. Time between restart attempts shall be user selectable between 1 - 10 seconds. Provide for restarting during deceleration without damage to the VFD, motor, or load. The VFD shall restart into a rotating motor by sensing the coasting motor speed and matching that frequency.

L. *Power Interruption Protection*: Prevent motor re-energizing after a power interruption into a rotating motor.

M. Communication *Interface*: VFDs shall include a BAS communications gateway. The Communications interface shall be one of the following selected at the time of shop drawing review and in coordination with the Temperature Controls Contractor and compatible to the Control System. Coordinate with Division 23 – Heating, Ventilating and Air Conditioning requirements.

1. BACNet
2. Modbus

N. Operation and maintenance features shall include:

1. *Panel-Mounted Operator Station*: Provide the following controls on the VFD operator interface or on the front of VFD enclosure:

    a. LOCAL-REMOTE pushbutton or selector switch
    b. RUN pushbutton to cause the motor to start and run, in local mode
    c. STOP pushbutton to cause the motor to immediately coast to a stop, in both the LOCAL and REMOTE modes
    d. Manual speed potentiometer to allow for manual speed control of the motor when in the LOCAL mode of operation

2.3 LINE CONDITIONING AND FILTERING

A. Provide DC link reactors for reduction of harmonic distortion or provide inherently protected DC bus.

B. Provide minimum 3% impedance input AC line reactor or DC link reactor as an integral part of the drive enclosure.

2.4 AUXILIARY CONTROL DEVICES

A. *General*: Factory installed in VFD enclosure except as otherwise indicated. Provide NEMA Type 4 enclosure where separately mounted, except as otherwise indicated.

B. *Pushbutton Stations, Pilot Lights, and Selector Switches*: NEMA Type 4/4X/13, watertight/corrosion resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30.5 mm, panel mounted, Allen-Bradley Bulletin 800H or approved equal. Pilot lights shall be full-voltage, 120 volts AC, 60 hertz, push-to-test LED type. LED lamp module shall be replaceable by removal of the color cap. NOTE: These auxiliary control devices are not required if the specified control and status functions are included as part of the operator interface on the drive.

C. *Control Power Supply*: Provide 120 VAC control power supply, isolated from the VFD's input power by a transformer. Control power transformer shall be oversized by a minimum of 50 volt-amperes. Both primary leads and all ungrounded secondary output leads of the power supply are to be fused. All fuses shall be current limiting rejection type mounted in a rejection type fuse holders that will only accept current limiting fuses.

D. Provide Form A "RUN" contact rated 120 VAC, 1 A for remote monitoring.

E. Provide Form A "OFF" contact rated 120 VAC, 1A for remote monitoring.

F. Provide Form C "FAULT" contacts rated 120 VAC, 1 A for remote alarm and "drive malfunction lockout".

G. The drive shall be able to start and stop from a two-wire control (dry contacts), three-wire momentary contact closure, drive mounted operator interface keypad and serial interface.

2.5 INTERLOCKS

A. Provide circuitry to accept a mechanical interlock contact input.

B. Provide circuitry to accept a motor disconnect switch position contact input that will cause the drive to shut down if the motor disconnect is opened while the motor is running.

2.6 ENCLOSURES

A. Enclosures shall be UL/NEMA Type 4 and shall comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)." The enclosure door shall be hinged for easy access and all internal components shall be easily accessible.

B. Enclosures shall be properly sized to house the VFD controller, control power transformer, cooling fan(s), input line reactor and DC link reactor, thru-the-door main disconnect and handle, input line fuses, a customer interface terminal strip and any and all other components required to make a complete and functional variable-frequency motor controller system as specified herein and as indicated on the Drawings.

C. Enclosures shall be properly sized to dissipate the heat generated by the controller within the limits of the specified environmental operating conditions. Enclosures shall protect all electronic parts from contaminated air and high ambient temperatures, and shall allow the unit to perform within specifications. The environmental design of the unit shall not compromise the unit reliability. Extend heat sink of drive through the rear of the enclosure to minimize the size of the enclosure to maintain drive operation within factory requirements in a 50°C ambient environment. The cooling system shall not compromise the NEMA Type 4 rating of the enclosure.

D. It is acceptable to provide a separately enclosed NEMA 4 or NEMA 4X rated VFD with a separately mounted line side disconnect switch provided in accordance with Specification Section 262816.16 – Enclosed Switches.

E. Metallic enclosure assemblies shall be finished with the manufacturer's standard color paint over a rust resistant phosphate undercoat on all surfaces.

F. A laminated plastic nameplate meeting the requirements of Section 260553 – Identification for Electrical Systems shall be mounted on the exterior surface of each VFD enclosure.

2.7 WIRING

A. The VFD units shall have provisions for terminating the incoming copper line conductors and outgoing copper load conductors.

B. Each unit shall include a copper ground bus and connector.

C. Wiring for the remote devices shall be terminated on terminal blocks inside the enclosure for extending to the remote devices. Separate terminal blocks shall be provided for control and power wiring.

2.8 APPROVED MANUFACTURERS

A. Variable-Frequency Drives and all components shall be:

1. ABB Model ACS580
2. Rockwell Allen-Bradley PowerFlex 70 or 750 Series
3. Toshiba Model AS3 or S15

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall furnish and install VFDs where required as indicated on the Drawings.

B. The Contractor shall momentarily energize each motor after the final connections have been made to ensure that correct rotation has been obtained.

C. Motor horsepower and power wiring and conduit sizes, as well as system interconnecting control wiring as shown on the Drawings, are based on the best available information. The Contractor shall be responsible for furnishing and installing, at no additional cost to the Owner, the proper size wiring based upon the actual motor horsepowers which will be used rather than those shown on the Drawings, to make all equipment and motors as actually furnished completely operable in accordance with the Specifications.

D. Any increase in motor horsepower resulting in the need for larger VFD, fuses, circuit breakers, wire and conduit sizes, etc., because of an increase in motor horsepower due to the Contractor’s final design of the particular system, shall be provided by the Contractor at no additional cost to the Owner.

3.2 INSTALLATION

A. Install all equipment in accordance with the manufacturer's written instructions and as shown on the Drawings.

B. For control equipment at walls, mount on steel structural channels bolted to wall. For controllers not at walls or columns, provide freestanding steel structural racks.

3.3 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. *Manufacturer's Field Services*: A factory-authorized service representative must be present to inspect the field assembly and connection of components and supervise the pretesting and adjustment of the VFDs.

B. Make any modifications, not previously made at the factory, to allow for operation of the VFD on a 480 volt, 3-phase, 3-wire grounded B-Phase power system.

C. Set carrier frequency to minimize the amount of audible noise generated by the motor.

D. Test and adjust skip frequencies required to protect mechanical equipment.

3.5 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

3.6 DEMONSTRATION

A. Arrange and pay for the services of a factory-authorized service representative to demonstrate operation and maintenance of the VFDs and provide two (2) hours of on-site training for Owner's personnel.

B. Schedule training with a minimum of five (5) days' advance notice to Construction Representative.

END OF SECTION 230515

SECTION 230523 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all manual valves as shown on the Drawings and specified herein.

1.3 SUBMITTALS

A. Submit manufacturer's data sheet for each type valve. Data sheets shall be marked with the valve code noted herein (BA-1, etc.) for purposes of identification.

B. Material source certifications and material test reports.

PART 2 - PRODUCTS

2.1 GENERAL

A. All valves shall comply with ASME 16.5, ASME B16.10, ASME 16.25, ASME B16.34, MSS-SP-45, MSS-SP-61, MSS-SP-84.

B. Valves shall provide shutoff per MSS-SP61 over a range of differential pressures up to the maximum pressure rating coincident with the operating temperature over a range up to the maximum temperature rating of the valves.

C. All valve stems shall be blowout proof.

D. Provide to Owner's Representative two operating wrenches for each type valve not equipped with handwheels or levers.

E. Provide suitable manual actuator for valves with unacceptably high operating torque due to service, size and style of valves.

F. All valves located 7' or more above floor, walkways or platforms, etc., shall be furnished with manufacturer's standard chainwheel operators, with chains extending to 5' above the operating level.

G. All valves shall have suitable devices for accepting padlock for locking the valve closed or open. When available, the valve manufacturer's standard locking arrangement shall be utilized.

H. Provide spare lubricant stick with each lubricated plug valve. Lubricant to be compatible with service requirements.

I. Packing shall be suitable for the intended service.

J. All valves 8" and larger on steam service shall have valved bypass around the valve.

K. Bore on butt weld valves shall match mating pipe.

L. Ship valves completely assembled with end covers.

M. Provide manufacturer's portable readout kit(s) designed for use with balance valves and triple duty valves to check differential pressure across components, equipped with 10' hoses, readout meter, carrying case, calculator, shut-off and vent valves, rated for 235°F liquid service at 250 psig. Range shall be compatible with balance and triple duty valves provided. Accuracy shall be about 1%.

2.2 MANUFACTURERS

A. Valve manufacturer is listed for purposes of clarification. Equivalent valves produced by an approved manufacturer may be used.

2.3 VALVES

A. GATE VALVES – THREADED:

TYPE	SIZE	ANSI PRESSURE CLASS	DESCRIPTION	MANUFACTURER'S NUMBER
GA-1	2" and under	800	Screwed Forged Steel OS&Y Graphite Packing	Hancock 950 S Vogt 12111

B. GLOBE VALVES – FLANGED:

TYPE	SIZE	ANSI PRESSURE CLASS	DESCRIPTION	MANUFACTURER'S NUMBER
GL-2	1/2" and over	150	Flanged 316 Stainless Steel OS&Y Stellite Trim Graphite Packing Welded Seat Rings	Powell Fig 2475 Or equal by Crane, Velan

C. CHECK VALVES - FLANGED:

TYPE	SIZE	PRESSURE PSIG	DESCRIPTION	MANUFACTURER'S NUMBER
CK-2	2-1/2" and over	150 S	Flanged 316 Stainless Steel Swing Check	Powell 2342 Or equal by Crane, Velan

D. BALL VALVES – THREADED AND SOCKET WELD:

TYPE	SIZE	PRESSURE PSIG	DESCRIPTION	MANUFACTURER'S NUMBER
BA-1	2" and under	150 SWP 600 WOG	Screwed Bronze Body, 2 Piece Stainless Steel Trim Stainless Steel Handle TFE Seats and Seals	Apollo 70-100 Jamesbury A1100 Watts B-6000 NIBCO T-580

			Vented Ball	
BA-2	2" and under	1500 WOG	Screwed Unibody 316 Stainless Steel Body, Trim TFE Seats and Seals	Apollo 96-100 Jamesbury Series 3000 Watts S-8100

E. BALL VALVES – TUBE FITTINGS:

BA-3	1" and under	2500 WOG	Compression Tube Fitting 316 Stainless Steel Body & Ball RTFE Seats and Seals Full Port Rating: 2500 psig at -20F to 300 F	Swagelok 40G Series Or equal by Parker

F. Needle Valves:

TYPE	SIZE	PRESSURE PSIG	DESCRIPTION	MANUFACTURER'S NUMBER
N-1	1" and under	6000 WOG	Compression ends 316 SS Vee stem PFA Packing Live Load Packing Bar Handle	Swagelok 20/26 Series Or equal by Parker

G. BUTTERFLY VALVES:

TYPE	SIZE	PRESSURE PSIG	DESCRIPTION	MANUFACTURER'S NUMBER
BF-1	2" - 12"	200 psig At 225 F	Lug Type, Drilled and Tapped Lever Operator (6" and under), Gear operator with Handwheel and position Indicator (8" and above), Ductile Iron Body Aluminum Bronze Disc Stainless Steel Stem EPDM Seat/liner Extended Neck	Stockham LD Nibco LD or equal by Bray, Center Line, Dezurick, Keystone

BF-2	2" - 12"	200 psig At 225 F	Lug Type, Drilled and Tapped Lever Operator (6" and under), Gear operator with Handwheel and position Indicator (8" and above), Ductile Iron Body 316 Stainless Steel Disc 316 Stainless Steel Stem EPDM Seat/liner	Stockham LD Nibco LD or equal by Bray, Center Line, Dezurick, Keystone

PART 3 - EXECUTION

3.1 INSTALLATION

A. If space permits, install valves with stems extending vertically upward or within 60° of vertical unless specifically shown otherwise.

B. All valves shall be installed in accessible locations for operation as well as for removal, repair or replacement.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all pipe hangers, supports, and supplementary structural steel beams as required for the HVAC piping and equipment systems.

1.3 DELEGATED DESIGN

A. Detailed design of mechanical pipe supports and seismic restraints is the Contractor's responsibility, except for pipe hangers specifically identified on the drawings.

B. Provide pipe supports and seismic-restraints complying with the requirements of the applicable International Building Codes, ASME Codes, and industry standards (e.g. MSS SP-58, Pipe Hangers and Supports and MSS SP-127, Bracing For Piping Systems: Seismic - Wind - Dynamic Design, Selection, And Application).

1.4 SUBMITTALS

A. Product data sheets for pipe hangers, supports, expansion bolts, adhesive anchors, dielectric materials, and spring hangers.

B. Shop drawings for pipe support structural steel and seismic restraints.

PART 2 - PRODUCTS

2.1 PIPE SUPPORT COATINGS

A. All pipe support materials located outdoors shall be galvanized.

2.2 MANUFACTURERS

A. Manufacturer's figure numbers indicated herein or shown on the Drawings are Anvil and are for clarification purposes.

B. Equivalent material by Basic Engineers, Inc. or Bergen-Paterson may be used.

2.3 HANGER RODS

A. Hanger rods shall be electro-galvanized machine threaded rods (Fig. 140, 253) ASTM A36 or ASTM A575 with threads conforming to ANSI B1.1.

B. Minimum rod size shall be as follows:

Pipe Size	Hanger Rod Diameter
2" and under	3/8"
2-1/2", 3"	1/2"
4"	5/8"
6"	3/4"
8" thru 12"	7/8"
14" thru 18"	1"
20" thru 24"	1-1/4"

2.4 SADDLES AND SHIELDS

A. Hot, insulated, horizontal piping shall have pipe covering protection saddles (Fig. 160-166A) at all support points.

B. Saddle depth shall be equal to or slightly greater than insulation thickness.

C. Cold, insulated, horizontal piping shall have galvanized insulation protection shields (Fig. 167) at all support points.

2.5 HANGERS

A. Unless otherwise shown or specified, hangers for horizontal piping shall be as follows:

1. Uninsulated pipe: Adjustable clevis, (Fig. 260).
2. Insulated Pipe – Hot (200°F or less): Adjustable clevis, (Fig.260).
3. Insulated Pipe - Hot (212°F and above):
   a. 2-1/2" and under: Adjustable clevis, (Fig. 260)
   b. 3" and above: Adjustable steel yoke pipe roll, (Fig. 181)
4. Insulated Pipe - Cold: Adjustable clevis, (Fig. 260)
5. Copper Pipe: Adjustable tubing ring, plastic coated (Fig. CT-99C)
6. Plate Lugs: Forged steel clevis, (Anvil Fig. 299 or equal)

B. Unless otherwise shown or specified hangers for vertical piping shall be riser clamps (Fig. 261) installed below hubs, or lugs welded to the pipe or clevis with a plate lug welded to elbow at top of riser.

2.6 UPPER ATTACHMENTS

A. Unless otherwise shown or specified upper attachments shall be as follows:

1. 2" and under (optional): C-clamp with locknut (Fig. 86)
2. 4" and under: Malleable beam clamp with extension piece (Fig. 229) or welded beam attachment (Fig. 66) with bolt and weldless eye nut (Fig. 290).
3. 6" and above: Beam clamp with weldless eye nut (Fig. 292) or welded beam attachment (Fig. 66) with bolt and weldless eye nut (Fig. 290).

B. Unless otherwise shown or specified upper attachments for structural concrete ceilings shall be as follows:

1. Concrete single lug plate (Anvil Fig. 47 or equal) or clevis plate (Anvil Fig. 49 or equal). Expansion anchors shall be stainless steel.

2. For pipe 3" and under (optional): Carbon steel, drop-in type female expansion anchor.

C. Provide medium welded steel brackets (Fig. 195) for small bore pipe (2" or less) supported from concrete or masonry walls, if shown on Drawings.

D. Piping 2-1/2" and smaller may be supported eccentrically (9" maximum) with 3 x 3 x 1/4" angles welded to columns or beams which are at least 8" deep.

E. Not more than one eccentric attachment per beam will be permitted.

2.7 COPPER PIPE

A. Unless shown otherwise in the Drawings, copper piping shall be supported as follows:

1. Copper finished extension split tubing clamp (Anvil Fig. CT-138R or approved equal).
2. Copper plated adjustable clevis (Anvil Fig. CT-65 or approved equal).

B. Copper pipe shall be isolated from steel pipe support members with minimum 1/8" thick rubber sheet.

2.8 U-BOLTS

A. U-bolts for steel pipe shall be carbon steel furnished with four hex nuts and two jam nuts. (Anvil Fig. 137 or approved equal).

B. U-bolts for copper pipe shall be plastic coated carbon steel with hex nuts. (Anvil Fig. 137C or approved equal).

2.9 TUBE SUPPORT

A. Tubing for instrumentation and controls shall be supported with James C. White Company, Inc., "Tubetrack" or equal.

2.10 PIPE STANCHIONS

A. Pipe stanchions shall be Fig. 63 or field fabricated equal from Schedule 40 pipe and 3/8" thick base plate.

B. Stanchion size shall be half the size of the pipe being supported but not less than 2" diameter.

C. Stanchion base plate shall <u>not</u> sit directly on floor but shall have minimum 1" non-metallic, non-shrink grout underneath.

D. Bolt base plate to floor with minimum ½" stainless steel expansion anchors.

2.11 PIPE SUPPORT STRUCTURAL STEEL

A. Wide flange beams shall be ASTM A992 (50 ksi minimum yield stress).

B. Miscellaneous structural steel, plates, etc. for pipe supports shall be ASTM A36 (36 ksi minimum yield stress).

C. Structural tubing shall be ASTM A500, Grade B (46 ksi minimum yield stress).

D. Welding of structural steel supports shall be completed with E70XX electrodes.

2.12 EXPANSION BOLTS

A. Expansion bolts and nuts used in connection with pipe support structures shall be stainless steel, Hilti "Kwik Bolt III" or approved equal by Powers or Red Head.

B. Embedment shall be as follows, unless noted otherwise:

Bolt Diameter, in.	Embedment, in.
1/2	3-1/2
5/8	4
3/4	4-3/4
1	6

2.13 ADHESIVE ANCHORS

A. Anchors for fastening to concrete shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge and 304SS anchor bolts with washer and nut, Hilti HIT HY200 with HIT-Z-R anchor bolt with minimum 6" embedment, or approved equal by Powers or Red Head.

B. Anchors for fastening to masonry shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge, 304SS screen tube (for hollow construction) and 304SS thread rod with washer and nut, Hilti HIT HY20 or approved equal by Powers or Red Head.

1. Pipe supports from masonry shall be installed only after review and approval by the Engineer.

PART 1 - EXECUTION

1.1 INSTALLATION

A. All piping shall be supported by suitable hangers to prevent excessive stress, swaying, sagging, or vibration.

B. Piping shall not be so restrained, however, as to cause it to snake or buckle between supports or anchors or to prevent movement due to expansion and contraction.

C. Hangers and supports shall be complete, including lock nuts, clamps, rods, bolts, couplings, swivels, inserts, required accessory items and secondary structural steel members.

D. Pipes shall be supported individually unless shown otherwise on drawings.

E. Provide supports, where pipe changes direction and at equipment connections.

F. Provide at least one hanger adjacent to each joint with mechanical couplings.

G. Weld pipe saddles to pipe.

H. Provide supplemental pipe support structural steel suitable for the applied loads as necessary to properly support all pipe.

1.2 SPACING

A. Unless otherwise shown on the Drawings the maximum spacing of supports for horizontal piping shall be as follows:

	Maximum Spacing, ft.	
Steel Pipe:	Steam, Liquids	Air & Gases
1/2”	5	6
3/4”	6	8
1”	7	9
1-1/4”	8	10
1-1/2”	9	11
2”	10	13
2-1/2”	11	14
3”	12	15
4”	14	17
6”	17	21
8”	19	24
10”	21	27
12”	23	30
16”	27	
18”	34	
24”	40	
Copper tubing:		
1” and under	5	
1-1/4”, 1-1/2”	7	
2” and above	10	
Cast Iron Pipe:		
6” and under	5 but not less than one support per pipe length	

B. Vertical pipe runs shall be supported and laterally braced at every floor level in multi-story structures and laterally braced only, at intervals not exceeding 15’ (10’ for 3” pipe and under) in other structures.

1.3 EXPANSION & ADHESIVE ANCHOR

A. Install in accordance with manufacturer’s instructions.

1.4 SEISMIC BRACING

A. Provide seismic (lateral and longitudinal) bracing for all piping with hanger length greater than 12” from the top of the pipe to the bottom of the support for the hanger.

B. Bracing shall be installed in such location and manner so as not to restrict thermal movement for hot piping.

C. Unless otherwise shown or approved, a pipe hanger used for lateral and longitudinal bracing shall include the following:

1. Clevis type hanger with pipe sleeve over horizontal through bolt.
2. 2 x 2 x 3/16 diagonal (1:1 slope) angle struts attached with bent clip angle to one side of hanger at through bolt. Weld or bolt other end of diagonal to support structure.

3. 2 x 2 x 3/16 angle to brace hanger rod for rods over 3' long. Weld angle to rod with 1/8" weld spaced 1" at 24" on center.

END OF SECTION 230529

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install identification labels for HVAC piping and equipment.

1.3 SUBMITTALS

A. Manufacturer's data sheet for identification labels.

B. Samples for identification labels.

C. Label Schedule, including a listing of all piping, duct, and equipment to be labeled with proposed content and coloring for each label.

PART 2 - PRODUCTS

2.1 GENERAL

A. Before ordering labels, Contractor shall review the proposed location for each label with the Owner's Representative and make any revisions to location or content as directed.

B. Contractor shall be responsible for obtaining all dimensions required to properly size and order labels.

2.2 LABELS

A. Label shall be heavy duty, self-adhesive, plastic type, rated for -40°F to 175°F surface temperature, which comply with ANSI/OSHA standards, Seton Opti-Code Self-Adhesive Pipe Labels or approved equal.

B. Label lettering shall be minimum 3”.

C. Label lettering shall be in accordance with manufacturer's recommendations.

D. Color coding shall comply with ANSI 13.1, latest.

E. Wording/color combinations shall be manufacturer's standard.

F. Direction of flow shall be included on each piping and duct label.

G. Piping Labels: Provide labels for the piping systems in accordance with Appendix A.

H. Duct Labels: Include identification of duct service using same designation or abbreviations as indicated on the drawings.

I. Equipment Labels: Include equipment's unique equipment number as indicated on the drawings. Confirm equipment name and number with Owner's Representative prior to proceeding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Apply labels only after installation, painting, and insulating have been completed.

B. All surfaces shall be cleaned of all scale, rust, oil, and foreign matter and shall be dry and free of frost prior to and during application of labels.

3.2 LABEL LOCATION

A. Review location of labels with Owner's Representative prior to installing.

B. Locate labels to be read easily from floor or platform levels.

C. Piping Labels: Locate labels as follows, unless indicated otherwise by Owner's Representative:

1. Within 10' of connected equipment.
2. At intervals not exceeding 30' of pipe.
3. At branch points.
4. At every sectionalizing or main shutoff valve.
5. On each riser at a point 5' above floors and platforms.
6. Near points where pipes enter or leave concealed spaces.
7. At access doors, panels, or manholes which permit view into concealed spaces.
8. Where flow pattern is not obvious.

D. Duct Labels: Locate labels as follows, unless indicated otherwise by Owner's Representative:

1. Within 10' of connected equipment.
2. At intervals not exceeding 30' of duct.
3. At branch points.
4. On each riser at a point 5' above floors and platforms.
5. Near points where ducts enter or leave concealed spaces.
6. At access doors, panels, or manholes which permit view into concealed spaces.

E. Equipment Labels: Locate labels as follows, unless indicated otherwise by Owner's Representative:

1. On equipment where accessible and visible.

PART 4 - APPENDIX "A"

4.1 PIPE IDENTIFICATION SCHEDULE

Piping System	Symbol	Marker Legend
Condensate		
High Pressure Condensate	HPC	Hi-Press. Condensate[1,2]
Low Pressure Condensate	LPC	Low-Press. Condensate[1,2]
Pumped Condensate	PC	Pumped Condensate[1,2]
Water		
Boiler Feedwater	BFW	Boiler Feedwater[1,2]
City Water	CW	City Water
Domestic Cold Water	DCW	Domestic Cold Water
Domestic Hot Water	DHW	Domestic Hot Water
Domestic Soft Water	DSW	Domestic Soft Water
Process Water	PW	Process Water[1,2]
Process Hot Water	PHW	Process Hot Water[1,2]
Process Soft Water	PSW	Process Soft Water[1,2]
Reverse Osmosis Water	RO	RO Water[1,2]
Air		
Compressed Air	CA	Compressed Air
Instrument Air	IA	Instrument Air
Chemical Feed	CF	Chemical Feed
Vent	V	Vent
Drain	D	Drain

Notes:
1. Provide signage at water outlets such as hose connections, open ended pipe, and faucets complying with International Plumbing Code requirements for identification of nonpotable water systems:
   A. "Nonpotable water is utilized for _____ water. CAUTION: NON-POTABLE WATER – DO NOT DRINK".
   B. Include IPC required pictograph.
2. Adjacent to the specified pipe identification labels, provide labels complying with the International Plumbing Code requirements for identification of nonpotable water systems:
   A. "CAUTION: NON-POTABLE WATER – DO NOT DRINK".

END OF SECTION 230553

SECTION 230700 – HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install thermal insulation for piping, ductwork and mechanical equipment as shown on the Drawings and specified herein.

B. Reinsulate any existing piping, ductwork, or equipment that is to remain that had insulation removed as part of demolition work or to make tie-ins. Unless noted otherwise, match existing insulation type, thickness, and finish.

C. Replace existing insulation which is damaged during construction.

D. Provide temporary insulation as required for personnel protection.

1.3 SUBMITTALS

A. Submit manufacturer's data sheet for each type of insulation to be used.

B. Submit manufacturer's data sheet for lagging to be used.

C. Submit material list clearly identifying insulation thickness, type, jacket, etc.

D. Submit drawing of insulation and lagging installation for ductwork identifying all material including insulation and lagging support and fastening systems.

1.4 QUALITY CONTROL

A. Insulation systems shall be industrial grade installations in strict accordance with manufacturer's recommendations, the National Commercial and Industrial Insulation Standards (by Midwest Insulation Contractor's Association), and these specifications, whichever is more stringent.

PART 2 - PRODUCTS

2.1 GENERAL

A. Insulation and insulating materials containing asbestos shall not be used.

2.2 FIBERGLASS PIPE INSULATION (TYPE 1)

A. Unless otherwise specified, insulation for piping shall be one-piece rigid molded glass fiber pipe covering having a density of 4 pounds per cubic foot, in compliance with ASTM C547, having a k-factor of approximately .22 at 75 F and suitable for temperatures to 850 F. Insulation shall have factory applied glass reinforced kraft paper bonded to aluminum foil

vapor barrier jacket, all service type, with self-sealing lap and butt strips. Insulation shall be Knauf ASJ-SSL, Owens Corning ASJ/SSL-II or approved equal.

B. For fittings, cover with two piece, factory molded insulation with 4 to 5 PCF density, ICA, Inc., HAMFAB or approved equal.

C. Except as noted below, indoor fittings and flanges shall have premolded PVC jacketing and no jacket other than all service jacket on insulation is required for indoor straight runs of pipe.

D. Piping listed below shall be covered with smooth aluminum jacketing. Jacket shall be manufactured from .016" type 3003 or 5005 aluminum. Jacketing shall have factory attached moisture barrier. Elbows and tees shall have aluminum jacketing of minimum .016" thickness. Jackets shall be Childers "E11-Jacs" and "Tee-Jacs", or approved equal. Flanges shall have aluminum jackets of minimum .016" thickness.

1. All piping within 3 feet above operating floor.

E. Mineral wool insulation of equal or better density, K-factor, and temperature rating may be substituted for the specified fiberglass insulation, subject to Engineer's approval.

2.3 ELASTOMERIC PIPE INSULATION (TYPE 2)

A. Insulation shall be flexible, closed cell, cellular elastomeric insulation in tube or sheet form, with a density range of 5 to 6-1/2 lbs./cu. ft., in compliance with ASTM C534, having a k-factor of approximately .27 at 75°F, a maximum water vapor transmission of 0.08 perm-inch per ASTM E96 and suitable for temperatures from -40°F to 180°F. AP “Armaflex,” Rubatex, or approved equal.

1. Insulation shall be non-wicking, mold and mildew resistant, and UV resistant.
2. With manufacturer’s recommended contact adhesive and tape for sealing joints.
3. For valves, fittings and flanges, fabricate sheet or tubing insulation into covers by butting and mitering joints as required, with sealed joints.
4. With manufacturer’s weather resistant finish on outdoor insulation.

B. All outdoor piping insulation shall be covered with 0.024” thick, stucco embossed, aluminum jacket, aluminum alloy, ASTM B209 with H-14 temper, with 4.5 mil LDPE moisture retarder, RPR Products, Inc. “Insul-Mate” or approved equal.

1. With 1/2” stainless steel bands on 12” centers and 1-1/2” back from all discontinuous ends of jacket.
2. Fittings shall be covered with 0.016” solid aluminum jackets.

2.4 REMOVAL INSULATION COVERS

A. Indoor flanged valves (including bonnets), piping specialties, and flanged in-line pipe instrumentation with Type 1 pipe insulation shall be insulated with tight fitting, reusable insulation covers.

B. Removal insulation covers shall consist of high density insulation suitable for operating temperatures (fiberglass, mineral wool, ceramic fiber) covered on outside with high temperature, coated glass fabric, with heavy duty adjustable straps with

buckles/hooks/loops. Inside of blanket shall be covered with fabric suitable to specified temperature or stainless steel square mesh woven wire cloth.

C. Insulation shall be sized for outer surface temperature of maximum 140°F and shall be minimum 1-1/2" thick for operating temperatures of 300°F or less and minimum 2" thick for operating temperatures of 300°F to 700°F.

D. Thread shall be 304 stainless steel, ten strand .0017.

E. Fabrication: Insulation will be held in place with stainless steel quilting pins spaced upon a minimum of every square foot with an ADC cap. A 2" placket will be installed at all parting lines for a watershed. A draw flap with stainless steel rope will be used wherever needed to assure a snug fit around any openings. Outside seams will be sewn with 4 layers to act as a wear barrier.

F. Insulation blankets shall be Young Distribution Services, Firwin, or approved equal.

PART 3 - EXECUTION

3.1 STORAGE

A. All insulation and accessory materials shall be stored in an area that is dry and protected from the weather before and during insulation application.

3.2 INSTALLATION – STANDARDS

A. Comply with insulation details included in the National Commercial and Industrial Insulation Standards (by Midwest Insulation Contractor's Association).

3.3 INSTALLATION – PIPE INSULATION

A. Insulation shall be applied to pipe, fittings, flanges, valves, specialties, etc. unless otherwise shown or called for.

B. All surfaces to be insulated shall be cleaned of all scale, rust, oil, and foreign matter and shall be dry and free of frost prior to and during application of insulation.

C. All required tests on piping must be completed and satisfactory test reports must be submitted to the Owner’s Representative prior to application of insulation covering joints.

D. Insulation shall be installed in a smooth, clean, workmanlike manner. Joints shall be tight and finished smooth. Cracked or chipped sections shall not be used in the work.

E. Insulation shall fit tightly against surface to which it is applied.

F. Sealant or cement shall not be applied until all previous applications of adhesives and cement have thoroughly dried.

G. Apply insulation in multiple layers and with expansion and contraction joints as required so as to permit expansion or contraction of pipe lines without causing damage to insulation, surface finish, or loss of insulating value.

H. Install insulation support lugs or rings on vertical pipe risers longer than 10 feet on 10 foot centers.

I. Preformed pipe covering shall be terminated at a sufficient distance from flanges to permit removal of bolts.

J. Insulation on flanges and flanged fittings shall overlap adjacent pipe covering at least 2".

K. Pipe insulation at expansion joints shall be held back a sufficient distance to permit the specified travel into the joint.

L. Valves shall be insulated up to the gland only so as to permit replacement of packing without disturbing insulation.

1. Glands shall be insulated with removable insulation covers.

M. Insulation shall be continuous through pipe covering protection saddles, guides and sleeves or openings in walls and floors.

N. Trap installations to include traps, stop valves, check valve, and hand-blow valve, as well as piping between the stop valves shall not be insulated.

1. Drip leg and piping up to first stop valve shall be insulated.
2. Piping downstream of the second isolation valve shall be insulated.

O. Pipe line strainers shall be insulated in such a manner as to permit removal of strainer basket with minimal disturbance to insulation and vapor barrier on the strainer body.

P. Stagger longitudinal and circumferential joints and tightly butt sections.

Q. Secure insulation with minimum 16 gauge galvanized wire on 9” centers.

3.4 INSTALLAITON - INSULATION WITH VAPOR BARRIERS

A. Insulation with vapor barriers: Provide vapor-tight insulation systems with 100% complete vapor barrier for elastomeric pipe insulation (Type 2).

1. Seal all longitudinal and circumferential joints vapor-tight with manufacturer’s recommended tape and contact adhesive.

2. Attach all ends of each insulation section to pipe, fittings, duct, etc. with insulation adhesive to provide sectionalized vapor dams.

3. For valves, fittings, flanges, pumps, etc. fabricate sheet or tubing insulation into covers by butting and mitering joints as required. Seal all joints with contact adhesive and/or tape in accordance with manufacturer’s instructions.

4. Attach insulation at termination points (such as valve stems) with insulation adhesive and then the manufacturer’s insulation mastic.

5. Apply insulation manufacturer’s weather resistant finish to outdoor insulation.

6. Maintain vapor barrier integrity at interface between new and existing insulation.

3.5 INSTALLATION – PIPE JACKETS

A. Lap joints downward to shed water.

B. Jacketing shall be lapped 2" and fastened with 1/2" wide stainless steel bands on 12" centers for piping.

1. Provide band 1-1/2" back from all discontinuous ends of jacket.

C. Counter flash exposed ends insulation.

D. Jacket shall not be run through pipe saddles and guides.

E. Comply with details if included on Drawings.

3.6 INSTALLATION - REMOVABLE INSULATION COVERS

A. Install removable insulation covers specified to be furnished herein and furnished with equipment.

3.7 INSULATION THICKNESS

A. Insulation thickness shall be in accordance with Appendix A.

PART 4 - APPENDIX "A"

4.1 PIPE INSULATION SCHEDULE

Service	Symbol	Insulation Type	Pipe Size	Insulation Thickness
Domestic Soft Water	DSW	Type 2	2" and under 2-1/2" and over	1/2" 3/4"
Process Soft Water	PSW	Type 2	2" and under 2-1/2" and over	1/2" 3/4"
Domestic Hot Water Process Hot Water	DHW PHW	Type 1	2" and under 2-1/2" and over	1.5" 2.0"
Pumped Condensate	PC	Type 1	2" and under 2-1/2" and over	1.5" 2.0"
RO Water[4]	RO	Type 1	2" and under 2-1/2" and over	1.5" 2.0"
Vents, Drains[1,2,3]	V, D	Note 3	2” and under	1/2”

Note:

1. When main pipe is insulated, insulate connecting vent and drain valves and no less than 2’ of adjacent vent and drain pipe.
2. Apply additional insulation as required for personnel protection on remainder of vent and drain pipe.
3. Match primary service pipe and insulation type and thickness.
4. Insulation on RO water lines is required only from level control stations (LCV) to deaerator, where RO and PC water are mixed.

END OF SECTION 230700

SECTION 230901 – INSTRUMENTATION AND CONTROLS FOR HVAC – POWER PLANT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install instrumentation and controls as shown on the Drawings and specified herein.

1.3 RELATED SECTIONS

A. Section 230501 – General Mechanical Requirement for HVAC

B. Section 232000 – Piping for HVAC

1.4 GENERAL

A. New instrumentation and control systems shall be fully coordinated and integrated with applicable process systems and with existing instrumentation and control systems to remain in place.

B. Obtain all field information (dimensions, clearances, sizes, quantities, construction details, etc.) as required to properly complete the work.

C. Control system subcontractor shall complete site visits as required to coordinate control system design with existing conditions.

1. Control system subcontractor shall field verify and document existing relevant control and instrument systems and their sequence of operation, configuration, set points, etc.
2. Documentation of existing conditions shall be furnished with controls submittals.
3. Controls subcontractor shall address issues regarding existing conditions and project requirements with Engineer.

D. Submittals shall include control plans indicating the proposed location of all new controls.

1.5 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 5 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 5 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 0.5 deg F.
    b. Water Flow: Plus or minus 1 percent of full scale.
    c. Water Pressure: Plus or minus 0.5 percent of full scale.
    d. Water Level: Plus or minus 0.5 percent of full scale.
    e. Electrical: Plus or minus 5 percent of reading.

1.6 SEQUENCE OF OPERATION

A. Refer to Drawings for control system operational requirements.

1.7 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate device identification, model, dimensions, capacities, performance characteristics, service and calibration range, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, operator interface equipment, etc.
3. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
4. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data.
5. Include written description of sequence of operation including schematic diagram.

B. Control Plans: Control plan drawings indicating the location of all new controls.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Panel layouts.
3. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, instrumentation, control devices, etc.
4. Wiring Diagrams: Power, signal, and control wiring.
5. Field wiring I/O connection drawings.
6. Details of control panel faces, including controls, instruments, and labeling.
7. Written description of sequence of operation.
8. Schedule of control dampers and valves indicating size, leakage, and flow characteristics.
9. Control System Hardware:
    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.

c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
11. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.
12. Layouts of operator interface display screens.
13. Trending, logging, and reporting formats

D. Coordination Plan: For each control system, list critical coordination activities to be completed with testing, adjusting, and balancing contractor and equipment service representatives.

1.8 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed control system component complies with ASHRAE 135.

B. Qualification Data: For manufacturer, designer, programmer, and installer.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

D. Field quality-control, calibration, testing, and adjusting reports.

E. Control panel manufacturer's UL 508A qualification and certification data.

1.9 CLOSEOUT SUBMITTALS

A. As-built shop drawings, final system programming, and final system graphics.

B. Operation and Maintenance Data: For instrumentation and control system to include in emergency, operation, and maintenance manuals. Data shall include, but not be limited to, the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

C. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a compact disc, complete with data files.
3. Backup shall completely restore the system in the event of a computer malfunction.

4. Provide two complete sets of back-up discs.
5. Device address list.
6. Printout of software application and graphic screens.
7. Software license required by and installed for workstations and control systems.

D. Warranty Certificates

E. Extended Service Agreement

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish recommended spare parts and price list.

1.11 QUALITY ASSURANCE

A. The control system designer responsible for the design of the control system shall be experienced in the design of control systems for gas/oil-fired steam plants and associated water treatment systems and experienced in the design of control systems using controls of same manufacturer and type to be provided for this project.

1. Evidence of such experience shall be provided to the Designer upon request.

B. Start-up service engineer(s) shall be experienced in controls and safeguards startup for gas/oil fired steam plants and associated water treatment systems.

1. The service engineer shall have at least 5 years' experience on similar projects.
2. Upon request, provide the names and phone numbers of at least 3 references for whom the service engineer has satisfactorily performed similar work in the past 24 months.
3. Controls experience during the past year shall be on controls of the same type and manufacturer as provided on this project.
4. Service engineer(s) shall be subject to approval of Construction Representative.

C. Control system designer shall have a field service representative, knowledgeable in the equipment and control system design to be provided on this project, located in the greater St. Louis metropolitan area, within a two (2) hour drive time from the project site.

1. Service representative shall provide "same day" response to all service calls and shall provide 24 hour/day, 7 day/week, 365 day/year service availability.

1.12 CERTIFICATIONS

A. Control panel manufacturer shall be UL 508A certified (Category Code NITW).

1.13 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from final completion and formal system acceptance by Construction Representative in writing.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site service in a timely manner upon failure notification. The maximum acceptable response time to provide this service at the site shall be 24 hours, Monday through Friday and 24 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

1.14 EXTENDED SERVICE AGREEMENT

A. The Controls Contractor shall provide an extended service agreement for all control systems installed under this contract.

B. During the one-year warranty period, the controls contractor will be required to provide a complete inspection and calibration of the control systems installed under this contract 6 months and 12 months after final acceptance of the project.

C. Contractor will be required to repair or replace any defective components found during this inspection under the terms of the warranty.

D. The Contractor shall submit a written report describing the results of his inspections.

E. Beginning at the end of the one-year warranty period and continuing for one year after this date, the Controls Contractor will be required to provide inspection and calibration of all controls installed under this contract 18 months and 24 months after final acceptance of the project.

F. All components found defective during this inspection shall be repaired or replaced at no additional cost to the Owner.

G. In addition to the regularly scheduled inspections, the Controls Contractor, during the service agreement period, shall respond within 24 to non-emergency service requests and within 8 hours to emergency service requests by the Owner.

H. The Contractor shall repair or replace any components found defective and recalibrate all necessary system controls to insure proper system operation at no additional cost to the Owner.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at project completion.

1.16 COORDINATION

A. Coordinate location of exposed control sensors with plans, room details, and Construction Representative before installation.

B. Coordinate with control systems included with equipment furnished by others.

C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

D. Coordinate with panelboards and motor control centers to achieve compatibility with starter coils, motor starters, and annunciation devices.

PART 2 - PRODUCTS

2.1 GENERAL

A. Control systems shall include an automated, programmed, panel mounted, electronic control systems, as indicated on the Drawings, for:

1. Condensate Tank water level control
2. Deaerator water level control

B. Control system shall be microprocessor based.

C. Major components of the control systems are specified herein. Any additional processors, chassis, input/output modules, non-volatile memory modules, communication modules, operator interface panels, lithium battery backup, terminal blocks, relays, panel wireways, circuit breakers, software, programming, switches, transducers, signal conditioners, power supplies, transformers, and any other control device or equipment, software, programming, etc., which are required to provide a complete operating control system shall be provided.

D. Controls shall be vibration and corrosion resistant, with aluminum or stainless-steel name tags engraved in accordance with control schematics and with mounting provisions as required.

E. Control system ranges shall be established such that normal full load operating conditions are less than full scale.

F. Control system shall be designed and assembled by the controls manufacturer or by others providing they are a recognized, established company experienced in the design of steam plant control systems and panel fabrication.

G. The control system program shall be stored in non-volatile memory that shall be retained when 120 VAC control power is removed.

H. Provide all miscellaneous hardware and material required to neatly and properly mount instruments.

2.2 CONDENSATE TANK LEVEL CONTROLS

A. Provide single-element condensate tank level regulating system to maintain a substantially constant water level in the condensate tank by controlling condensate flow to the deaerator.

1. In addition, provide a high deaerator level control loop to limit condensate flow to deaerator on high deaerator water level.

B. Level control loop input shall be tank level in accordance with the standard concept of single-element control.

C. Condensate Tank Level Control: Condensate tank level control system shall continuously and automatically control condensate storage tank level. Level control system shall include, but not be limited to:

a. Condensate tank level indicating transmitter
b. Condensate tank single-loop digital level controller
c. Condensate tank level control valve with electric actuator, positioner, and position feedback signal
d. Maintain a constant water level, +/-1".

D. Deaerator High Level Control: Deaerator high level control system shall continuously and automatically control deaerator high level by overriding the condensate tank level control signal when deaerator tank level is high. Level control system shall include, but not be limited to:

a. Deaerator high level indicating transmitter
b. Deaerator single-loop digital high-level controller
c. Low select signal integration with condensate tank level controller

E. Provide the following alarm functions:

1. Condensate tank low water level alarm with alarm light and audible alarm.
2. Condensate tank high water level alarm with alarm light and audible alarm.
3. Deaerator high level alarm with alarm light and audible alarm.

F. Provide the following indicating functions, as a minimum, mounted on the face of the control panel:

1. Power switch.
2. Green power on light.
3. Alarm horn with silence pushbutton.
4. Alarm annunciator lights.
5. Condensate tank level setpoint.
6. Condensate tank level indication.
7. Condensate tank level control signal.
8. Condensate tank control valve position feedback signal.
9. Condensate tank low level alarm light.
10. Condensate tank high level alarm light.
11. Deaerator high level setpoint.
12. Deaerator level indication.
13. Deaerator high level control signal.
14. Deaerator high level alarm light.
15. Condensate level control valve signal status:
    a. Condensate tank level signal controlling.
    b. High deaerator level signal controlling.

G. Controller digital output alarm signals shall be processed using relay control logic with individual 120 VAC, plug-in, "ice cube" type control relays.

H. Alarm Features:

1. When the unit is in an alarm condition, both a red alarm light and an audible signal shall be activated.
2. The audible alarm can be silenced by the operator by pressing the "Alarm Silence" pushbutton.

2.1 DEAERATOR LEVEL CONTROLS

A. Provide single-element tank level regulating system to maintain a substantially constant water level in the deaerator by controlling treated make-up water flow.

B. The control loop input shall be tank level in accordance with the standard concept of single-element control.

C. Provide the following control functions:

1. Deaerator Level Control: Deaerator level control system shall continuously and automatically deaerator level. Level control system shall include, but not be limited to:

a. Continued use of existing level transmitter.
b. Continued use of existing single-loop digital controller.
c. New Deaerator level make-up water control valve with electric actuator, positioner, and position feedback signal.
d. Maintain a constant water level, +/-1".

2.2 CONTROL SYSTEM COMMUNICATIONS

A. New controllers shall interface with the Owner's existing Building Automation System (BAS) for monitoring/status reporting and archival of data.

1. Provide new control loop displays on existing BAS operator interface station.

B. Provide all required communication interfaces with facility's existing building automation system (BAS):

1. Existing Facility Building Automation System: Automated Logic Corporation.
2. Existing BAS Controls Contractor:
   a. Premium Mechanical and Automation
   b. 3185 North High Street
   c. Jackson, Missouri 63755
   d. 573-243-3918
   e. Contacts: Randy Henley, Don Henley

2.3 CONTROL PANEL

A. Controllers and all associated equipment, terminal strips, switches, indicator lights, alarm horn, control relays, etc. shall be mounted in a factory wired, control panel.

B. The control panel shall be a NEMA 4 or 12 enclosure with a hinged door with lockable handle and inner back panel.

C. Nameplates:

1. A nameplate shall be furnished for each item on the panel describing the function of the item.
2. Nameplates shall be white laminated plastic with engraved black characters, minimum 3/16" high.
3. Permanent nameplates or tags shall also be provided inside the panel to label all devices.

D. The control panel shall have a single-point of connection for a 120 VAC single-phase power supply terminating in a circuit breaker, with a minimum short circuit interrupt rating of 10,000 amps RMS symmetrical.

E. All single conductor internal panel control wiring shall be minimum 16 AWG Type THHN, 600V stranded copper wire rated for 90°C. Multi-conductor electronic cable shall be minimum 18 AWG copper, shielded as required.

F. All electrical instruments and devices in the panel shall be factory wired to DIN rail mounted, UL Listed, 600V, high density modular IEC style terminal blocks located inside the panel. Interconnecting wiring from external devices to the panel, as well as interconnecting wiring within the panel, shall terminate at the terminal blocks. Terminals on terminal blocks shall be plainly and permanently marked to correspond with the identification shown on the electrical diagrams.

G. The panel shall be provided with a copper ground bus, bonded to the panel enclosure and having sufficient terminals for termination of all grounding conductors.

H. Conductors shall be identified at each termination by marking with a number to correspond with the wiring diagrams. In addition, grounding conductors shall be identified with green insulation or green tape at termination points.

I. Panel wiring shall be contained in panel wireways wherever possible.

1. Wires not in wireways shall be properly bundled.
2. The panel wireway material shall not support combustion.
3. It shall be made of non-warping, insulating material rated for the highest voltage applied to any conductor contained.
4. The wireway shall not contain exposed metal parts, except for the mounting screws where used.

J. Provide an alarm horn: Alarm horn shall be 120 VAC, 60 Hz, 100 dB minimum at 10 feet, Federal Signal Model 350 with NEMA 4 gasket, or approved equal by Ametek Panalarm or Edwards, for annunciation of alarm conditions. Horn shall be semi-flush mounted in the face of control panel. Provide an "alarm silence" push button.

K. Pilot lights, pushbuttons and selector switches shall be NEMA Type 4/4X/13 watertight/ corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30.5 mm, 30 mm or 22.5 mm size. Allen-Bradley Bulletin 800 or approved equal. Pilot lights shall be 120VAC, push-to-test, full voltage with high intensity LED type lamps. Lamps shall be replaceable by removal of the color cap.

2.4 SINGLE LOOP DIGITAL CONTROLLERS

A. Controllers shall be microprocessor based, single or dual loop, indicating type.

B. Controllers shall include hand/auto capability.

C. Controllers shall include biasing capability to allow the operator to bias controller output.

D. Controllers shall have permanent nameplates clearly describing control function.

E. Controllers shall have a highly visible, menu-driven graphic faceplate display with split screen capability and bar graph display.

F. Controllers shall be menu-driven with multifunction "soft" keys on faceplate for function selection.

G. Controller shall be equipped with "peer-to-peer" communications capability to allow for uploading or downloading the configuration program from one controller to another.

H. Control strategy shall be configured using standard function blocks that shall be either preassigned in the controller memory or user configurable.

I. The configuration program shall be stored in non-volatile memory, i.e., the controller program shall not be erased when the input power to the controller is turned off. If battery backed up program chips are utilized the battery life shall be a minimum of seven (7) years.

J. Each controller shall be provided with a means to download/upload a copy of the configuration program to/from a separate storage media; floppy disk, cartridge or EPROM chip. All required software and hardware; configuration and tuning terminal, storage cartridge(s), floppy disk(s), EPROM chips, interconnect cables, etc. shall be included.

K. Provide the Owner with a back-up copy of the configuration program for each controller that is clearly identified and labeled. Provide all required instructions and procedures for uploading and downloading the configuration program from and to the backup media; cartridge, floppy disk, or EPROM chip, as part of the system O&M manuals.

L. Controller shall provide nominal 24 VDC power supply for up to two (2) transmitters.

M. Controller shall operate from nominal 120 VAC, 60 Hz power source.

N. Controller shall be suitable for semi-flush panel mounting and shall include all necessary mounting brackets and hardware.

O. Controllers shall be suitable for operation in an ambient environment of 0° to 50°C and 15% to 90% non-condensing.

P. Controllers shall have the capability to be interfaced to the Owner's existing Building Automation System (BAS) for monitoring/status reporting and archival of data as noted above.

Q. Controllers shall be one of the following:

1. Honeywell UDC2500, UDC3200, UDC3500
2. Preferred Instruments PCC-IV Multiple Loop Controller
3. Yokogawa Model YS1700 Single-Loop Programmable Controller

2.5 TERMINALS

A. Provide portable hand-held communications terminal suitable for programming and troubleshooting all transmitters.

2.6 LEVEL ELEMENTS AND TRANSMITTERS:

A. LIT-02: Float type magnetic liquid level gauge (gas/liquid interface) with externally mounted level transmitter.

1. Service: Atmospheric, steam condensate storage, 200°F, 0.96 specific gravity.
   a. With some high pressure returns with flashing potential.
   b. Tank diameter: 72".
2. Minimum Pressure/Temperature Rating: 30 psig at 250°F.

3. External magnetic indicator, high visibility red and silver aluminum flags, magnetically interlocked with float, mechanical stops to allow only 180-degree rotation, graduated in feet and inches, stainless steel housing with glass indicator window.
    a. Resolution: +/- 0.25".
    b. Measuring Range: 60"
    c. Mounting: Right mount. Field verify.
4. Float: Internal, 360-degree magnet, 316L stainless steel, suitable for applications to 100 psig at temperatures from 50°F to 300°F.
5. Chamber: 2 ½", Schedule 40, 316L stainless steel, with top and bottom raised-face slip-on flanges, composition gaskets, with ½" 3000 lb FNPT drain and vent connections, adjustable support clips.
    a. With suitable drain valve with plug.
    b. With vent plug.
    c. With bottom clearance sufficient for float removal.
6. Process connections: Flanged, side-mounted, 1½", Schedule 40, 316L stainless steel, on 60" centers.
7. Transmitter: External mounted magnetostrictive type.
    a. Top mount.
    b. Measuring Range: 60".
    c. Sensor: 316 stainless steel, 5/8" diameter probe, 316 stainless steel mounting brackets, suitable for -200°F to 750°F operating temperature
    d. Housing: Epoxy coated aluminum alloy or stainless steel, NEMA 4X, 1/2" NPT conduit connection, and single terminal block.
    e. Local Indication: Integral 5-digit LCD.
    f. Output: Two wire, 4-20 mADC and HART "smart" digital communication
    g. Power Supply: 12-42 VDC loop powered
    h. Resolution: +/- 0.25".
    i. Stability: +/- 0.15% of upper range limit over 10 years
8. Insulation jacket: Factory installed, removable, insulation blanket suitable for temperatures to 500°F, 2" ceramic wool enclosed in silicone coated fiberglass cloth.
9. Welding and welder qualifications in accordance with ASME Section IX.
10. Factory hydrostatic test to minimum 100 psig.
11. Factory tested and calibrated.
12. Stainless steel name tag
13. Manufactured to ASME B31.1, ANSI/ASME B16.5 Class 150
14. Manufacturers: Magtech LG/LTM Series, or approved equal by ABB, Babbit, Magnetrol, Bliss, Penberthy.

B. LIT-03: Differential pressure type transmitter for level measurement.

1. Material: 316L stainless steel wetted materials
2. Mounting: Pipe mount bracket and hardware
3. 3-way stainless steel valve manifold for differential pressure
4. Furnish with seal pot for upper steam/vapor side connection
5. Accuracy: +/- 0.01% of span
6. Stability: +/- 0.15% of upper range limit over 10 years
7. Power Supply: 12-42 VDC
8. Output: two wire, 4-20 mADC and HART "smart" digital communication
9. Housing: Aluminum alloy, NEMA 4X, 1/2" NPT conduit connection, and single terminal block.
    a. One threaded plug shall be furnished for the unused conduit opening.
10. Local Indication: Integral 5-digit LCD.
11. Stainless steel name tag

12. Ambient Temperature Range: -40°F to 185°F
13. Manufacturers:
    a. Rosemount Model 3051
    b. Yokogawa EJA Series
    c. Honeywell STT 3000

2.7 CONTROL VALVES

A. Control valves shall be provided close flow control throughout the required operating range.

B. Level control valves shall be sized for the specified design capacity and pressure drop at no greater than 80% open.

C. Control valves shall be industrial duty, two-way, characterized, ball type with electric actuator, suitable for the service conditions.

D. Electric Actuated, Ball Style: Valves shall be single port ball style with characterized seat, as indicated below and on the drawings:

1. Body Material: 316 stainless steel.
2. Pressure/temperature rating: ANSI Class 150
3. Connections: ANSI Class 150, raised face, flanges.
4. Ball: 316 stainless steel, hard nickel coating.
5. Characterized Seat: Self-lubricating, Teflon or graphite impregnated sintered stainless steel.
    a. 60 to 120 degree characterized.
    b. Equal percentage characteristic.
    c. Size for flow and differential pressure as indicated on the Drawings at about 80% open.
    d. Turndown of 30 to 1 between 20% and 80% open.
6. Class VI shut-off.
7. Anti-cavitation trim as required.
8. Body Seal: PTFE coated 316SS.
9. Round Port Seat: Polyfill.
10. Stem: 17-4PH, hard nickel coating, blow-out proof.
11. Steam Seal: Polyfill-PEEK, live loaded.
12. Thrust Bearings: Polyfill-PEEK.
13. Valves and actuators shall be rated for maximum differential pressure of no less than 100 psi in closed position.
14. Valve operational speed shall not exceed 30 seconds for 90-degree valve movement.
15. Actuator: Electric with integral positioner.
    a. Electric Motors: Totally enclosed, non-ventilated, high starting torque, brushless, split phase capacitor, start/run reversing AC motor.
        1) Electrical Characteristics: As required for the application.
        2) Thermal Overload Motor Protection: Auto reset thermal switch embedded in the motor winding to trip when the maximum winding temperature is exceeded.
        3) Heater.
        4) Mechanical brake.
        5) 120 VAC, 60 Hz power supply.
    b. Positioner: Actuator-mounted, characterizable, electronic type, 4-20 mADC control signal, 4-20 mADC position feedback signal, direct or reverse acting as required.
    c. Duty cycle: 100 percent.

d. Ambient temperature range: -31 to 250 degrees F.
e. Resolution: 100 to 400 increments through 90-degree travel.
f. Power Gears: Permanently lubricated, alloy steel spur gears to final stage aluminum bronze worm sector gear.
g. Bearings: High quality alloy steel sleeve and ball bearings.
h. Housing: NEMA 4X or better, watertight, corrosion-resistant, robust aluminum die cast.
i. Two SPDT auxiliary switches
j. Visual position indicator
k. Manual override handle
l. Adjustable mechanical stops
m. Torque output range appropriate for the differential pressure and pressure and temperature conditions.
n. Fail safe as indicated on the drawings, with spring return on loss of signal or power.
o. De-energized (spring) and/or power closure time shall be no faster than 3 seconds to minimize water hammer and no greater than 10 seconds.

16. Valve shall be Worcester Series CPT Series with Series 75 Actuator, or approved equal by Bray, or Emerson.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install controls in accordance with manufacturers' instructions and in accordance with approved coordinated wiring diagrams to provide the intended function.

B. Control devices shall be rigidly secured and installed plumb and level in accordance with the mounting details on the Drawings.

C. The Contractor shall furnish and install all conduit and wiring as required for all control and instrumentation circuits, making all required connections.

D. Review installation with Construction Representative prior to proceeding.

E. Install control panels in a readily accessible location between 5'-0" and 6'-0" from the floor to the top of the panel.

3.2 MANUFACTURER'S FIELD SERVICES

A. Provide services of a qualified manufacturer's representative to:

1. Check complete installation for conformance to manufacturer's recommendations.
2. Complete field quality control.
3. Place the system into service.
4. Make all adjustments required for full conformance to design and specified requirements.
5. Perform all demonstrations and tests.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Calibration: Field verify factory calibration of all instrumentation.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
3. Test and adjust controls and safeties.
4. First four subparagraphs below are for systems with pneumatic components.
5. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
6. Test each device through its full operating range to verify that safety and operating control set points are as required.
7. Test hardware interlocks.

B. Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check system wiring as follows:
    a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    b. Verify that devices are protected from power supply surges.

C. Replace damaged or malfunctioning controls and instrumentation and repeat testing procedures.

3.4 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals.
4. Use test equipment with accuracy at least double that of instrument being calibrated.
5. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

6. Level:
    a. Calibrate level transmitters at 0, 50, and 100 percent of span.
    b. Calibrate level and pressure switches to make or break contacts at set points indicated.

7. Pressure:
    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts at set points indicated.

8. Temperature:
    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts at set points indicated.

9. Provide diagnostic and test instruments for calibration and adjustment of system.
10. Provide written description of procedures and equipment for calibrating each type of instrument.
    a. Submit procedures review and approval before initiating startup procedures.

3.5 START-UP AND TESTING

A. Operating: Tests shall be run in presence of Construction Representative.

B. Procedure:

1. Operate control systems for eight hours.
2. Demonstrate all features of the control system including interlocks and diagnostics.

C. The Construction Representative will observe startup and Contractor testing of the control systems.

1. Coordinate the startup and contractor testing schedules with the Construction Representative.
2. Contractor shall provide a minimum of 10 working days' notice prior to startup and testing.
3. Proper operation shall be demonstrated to the satisfaction of the Construction Representative.

3.6 DEMONSTRATION

A. Demonstrate new control and instrumentation system performance.

B. Demonstrate continued performance of existing control and instrumentation systems.

C. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain instrumentation and controls.

END OF SECTION 230901

SECTION 232000 – PIPING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all HVAC piping as shown on the Drawings and specified herein.

1.3 GENERAL

A. Piping shall be fabricated and installed in accordance with the Code for Pressure Piping, ANSI B31.1 (Latest) "Power Piping".

1.4 SUBMITTALS

A. Submit product data:

1. Piping materials
2. Solder filler metal for copper tube
3. Integrally reinforced branch fittings
4. Antisieze compound

B. Quality control manual.

C. Material source certifications.

D. Material test reports.

E. Qualifications for third party weld inspection company and inspector(s).

F. Welder test reports.

G. Weld test reports.

H. Leakage test reports.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. Piping materials shall be in accordance with the schedule below and the piping specifications that follow this section.

Piping System	Symbol	Piping Specification No.
Domestic Hot Water	DHW	1
Domestic Soft Water	DSW	1
Process Hot Water	PHW	1
Process Soft Water	PSW	1

Pumped Condensate	PC	2
Reverse Osmosis Water	RO	3
Compressed Air	CA	4
Instrument Air	IA	4
Chemical Feed	CF	5
Instrument Tubing	IT	5
RO Tank Vent	ROV	6
RO Tank Drain	ROD	6

B. All pipe materials shall be new, clean, and free of debris.

C. All pipe and large bore fittings shall be delivered to the site with plastic end caps.

PART 3 - EXECUTION

3.1 STORAGE

A. All piping and accessory materials shall be stored above the ground in an area that is dry and protected from the weather.

B. Piping exposed to the ground or unsanitary conditions shall be removed from the site.

3.2 PIPE ERECTION

A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Any items which are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.

B. Pipe lines shall be run straight and true with a minimum use of joints and with only such offsets as may be required to clear interferences and to provide necessary clearance or headroom or provide the necessary flexibility in the piping system.

C. Changes in direction of pipe lines shall be made with approved fittings or pipe bends only.

D. Miter joints in welded pipe assemblies shall not be used except where shown on the Drawings.

E. Backing rings shall not be used on butt welded joints.

F. Tubing shall be installed with the use of tubing bends, to the maximum extent possible to minimize the use of fittings.

G. All prefabricated piping shall be arranged with extra tangent, loose flanges, field joints or other provisions to permit field adjustment to suit construction tolerances and to avoid interferences. No claims for extras for reworking prefabricated piping will be allowed other than for a major change in plans.

H. Provide flanges or unions at all final connections to equipment, traps and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shut-off valves.

I. Pipe shall be cut to exact measurement and installed without springing or forcing. Particular care shall be taken to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment or building elements with piping connections or piping supports.

J. All cutting residue shall be cleaned from the interior of pipe prior to welding or joining.

K. All instrument tubing shall be run in a neat, straight fashion free from waves.

L. All flange bolts and nuts shall have threaded surfaces thoroughly coated with high temperature, anti-sieze paste. The paste shall be Nickel Grade Anti-Sieze (Lub-O-Seal Company, Inc.) or approved equal.

M. Flange bolts shall be properly tightened with torque wrenches to gasket manufacturer's requirements. See attachment to this specification.

N. Slugging wrenches and pneumatic impact wrenches shall not be used for tightening flange bolts.

O. All threaded pipe work is to be assembled with full threads, including all fittings, valves, unions and specialties.

P. Threads shall be full and clean cut and the pipe shall be reamed and filed, removing all burrs from the interior.

Q. Threaded work shall be made up with a suitable pipe joint compound.

R. Mating flanges shall have same type face. Raised face flanges shall have raised portion machined off before bolting to flat face flanges.

S. All pipe shall be erected and supported in such a manner as to provide for expansion and contraction without harmful strain to the building structural members, pipe and pipe supports.

T. Consideration shall be given to insulation thickness when routing piping such that adequate clearance is provided to avoid interfering with insulation.

3.3 BRANCH CONNECTIONS

A. Branch take-offs for steam, air and gas lines, shall be from top or sides of mains or headers. Branch take-offs for liquids shall be from bottom or sides.

B. Branch connections shall be made with standard tees and 45° laterals of the type required for the service.

C. In place of standard tees and 45° laterals in black steel piping systems, Contractor may use integrally reinforced weld-on fittings as follows:

1. For ¾" and smaller drain, vent, and instrument connections on large bore pipe (2-1/2" and larger).
2. Only where specifically shown on the Drawings or approved by the Engineer in writing.

D. Integrally reinforced branch connections shall maintain full pipe strength and shall comply with ANSI B31.1, ANSI B16.9, and MSS-SP-97 Standard – Integrally Reinforced Forged Branch Outlet Fittings. Fittings shall be Bonney Forge Weldolet or approved equal.

3.4 DRAINING AND VENTING

A. Unless otherwise indicated on the Drawings, all horizontal lines, including runouts and branches, shall pitch to low points to provide for complete drainage or removal of condensate and venting. Slope unless otherwise indicated, shall be 1" in 40'.

B. Maintain constant slope where lines are pitched for venting and drainage. No lines shall have pockets due to changes in elevation unless indicated on the Drawings. In such instances proper provisions for draining and venting shall be provided.

C. Provide 3/4" drain valves fitted with 3/4" hose thread adapter at all low points of process or water piping systems and where indicated on Drawings to permit complete or sectionalized draining.

D. Provide manual air vents with 3/4” vent valves at the high points of piping systems and where shown on Drawings.

E. Provide drip legs at low points and at the base of all risers in steam, compressed air, and gas lines.

1. Unless otherwise shown on the Drawings, drip legs shall be full line size on lines through 4" and a minimum of 4" but not less than half line size on lines over 4".
2. Drip legs shall be 12" minimum in length with a cap.
3. Drip legs on steam lines shall be Schedule 80 pipe.

3.5 SLEEVES

A. Furnish and install sleeves for all pipes passing through floors and walls, slabs, grade beams and foundations.

B. When possible, layout, size and locate all sleeves such that they are installed prior to pouring concrete or when masonry is being constructed.

C. Sleeves shall be standard weight galvanized steel pipe, or 10 gauge galvanized sheet metal to be closed with longitudinal weld joint, having square cut ends with anchoring lugs welded on.

D. Horizontal sleeves through walls, grade beams, foundations and partitions shall be grouted in place and shall be flush with finished wall faces.

E. Vertical sleeves through floors shall extend 2" above finished floor and be flush on under side.

F. Size sleeves such that internal diameter is 2" larger than O.D. of bare pipe for uninsulated lines and 2" larger than O.D. of insulation and jacket for insulated lines.

G. Center pipes in sleeves. Sleeves in pits or below grade shall be painted or coated with one coat of coal tar paint.

H. Roof openings shall have collars flashed into roofing system and weather hoods attached to pipe. Final detail shall comply with roofing manufacturer's requirements.

3.6 DIELECTRIC CONNECTIONS

A. Pipe joints connecting dissimilar metals shall be insulating, dielectric connections. Such joints, including dielectric material, shall be rated to withstand the temperature, pressure and other characteristics of the service for which it is to be used, including testing pressure.

B. Screwed joints shall be made with insulating unions and couplings.

C. Flanged joints shall be made up with flange insulation kits consisting of a suitable gasket, bolt sleeves and washers.

3.7 WELD TESTING

A. The Contractor shall test all pipe welds for proper quality using nondestructive, ultrasonic testing procedures in accordance with the applicable ANSI/ASME codes.

B. Testing will be completed by Contractor’s third party, certified weld inspector, subject to approval of Construction Representative and Engineer.

C. Contractor shall complete any required repairs at Contractor’s cost.

3.8 LEAKAGE TESTING

A. Tests shall be performed and approval of tests obtained in writing prior to cleaning, backfilling, insulating, painting or concealing pipe.

B. Notify Owner’s Representative 24 hours in advance of testing.

C. Prepare and keep records of each system or section of system tested.

1. Test reports shall be signed as approved by Owner's Representative with one copy to Owner's Representative.
2. If additional copies are required by those persons having legal jurisdiction, Contractor shall furnish them.
3. Provide Certification of Leak Test to Spire Gas Company.

D. Test reports shall include, but not necessarily be limited to, the following.

1. Identification of piping system or section tested.
2. Date of test and date of Owner's Representative approval signature.
3. Testing medium and method or description of test procedure.
4. Test pressure, duration of test and recorded pressure drop.

E. Pressure tests shall apply to piping only with all equipment, traps, relief valves and instruments blocked off or disconnected. In no case shall piping or any component be subjected to pressures exceeding 90% of their published rating. All system valves within section being tested shall be open. Provide temporary restraints on expansion joints and flexible connections during pressure testing.

F. The Contractor shall provide all compressors, pumps, gauges, pipe, fittings, closures, etc., required for the tests. Blanks shall be furnished and installed wherever necessary to prevent cold test water from coming in contact with hot valves. Remove blanks after testing.

G. Unless otherwise indicated hydrostatic testing medium shall be potable water and pneumatic testing medium shall be compressed air.

H. Pneumatic testing for any purpose shall require evacuation of all personnel not directly involved in performing test and preliminary test of 25 psig. Swab all joints with standard high film strength soap solution and check for bubbles.

I. Pneumatic tests may be substituted for specified hydrostatic tests where freezing conditions may occur when approved by Owner's Representative.

J. Hydrostatic and pneumatic tests shall apply to piping as indicted in the following schedule. The pressure shall be gradually raised to the value given and the source then blocked off. Pressures shall be observed after the pipe and contents have stabilized at the ambient temperature and the source of test pressure shut-off. All joints shall be visually examined during test.

LEAKAGE TEST SCHEDULE

Service	Symbol	Hydrostatic Test Pressure psig	Pneumatic Test Pressure psig	Minimum Time minutes
Pumped Condensate	PC	100		30
Domestic Hot Water	DHW	150		30
Domestic Soft Water	DSW	150		30
Process Hot Water	PSW	150		30
Process Soft Water	PSW	150		30
Reverse Osmosis Water	RO	150		30
Compressed Air	CA		100	30
Instrument Air	IA		100	30
Chemical Feed	CF	150		30

K. Leaks shall be repaired and complete testing procedure repeated.

L. Upon successful completion and approval of the tests, the piping shall be relieved of pressure, drained, cleaned and put into normal operation except for potable water which shall first be disinfected.

M. All new piping not specifically listed above shall receive an initial service leak test by gradually bringing the system up to normal operating pressure for at least 10 minutes while examining for leaks.

3.9 CLEANING

A. Prior to assembly of pipe and piping components, all loose dirt, scale, oil and other foreign matter on internal or external surfaces shall be removed by means consistent with good piping practice. Chips and burrs from thread cutting operations shall be blown out of pipe before assembly. Cutting oil shall be removed from internal and external surfaces.

B. During fabrication and assembly, slag and weld spatter shall be removed from pipe joints by peening, chipping and wire brushing.

C. Contractor shall arrange for visual inspection of all pipe by Owner’s Representative prior to closure.

D. All completed piping systems except those listed immediately below shall be cleaned:

1. Vent
2. Drain

E. Notify Owner's Representative prior to starting any cleaning operation. Consult with Owner's Representative with regard to scheduling.

F. It shall be Contractor's responsibility to arrange for proper disposal of cleaning and flushing fluids.

G. Prior to blowing or flushing piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

1. Provide temporary pipe spools in place of inline instrumentation, pipe specialties, etc. which are not suitable for exposure to cleaning procedures.
2. Provide temporary piping as required for proper and safe disposal of flushing fluids and venting of blowout gases outdoors to a safe location.

H. Water Flush: Flush pipe and components with clean water until all discharge from system is clean. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of lines, ends of headers and as otherwise required to flush entire system. Water flush shall apply to the following systems:

1. Pumped Condensate
2. Domestic Hot Water
3. Domestic Soft Water
4. Process Hot Water
5. Process Soft Water
6. Reverse Osmosis Water
7. Chemical Feed

I. Air Blow: Blow out pipe and components with dry oil free air, or nitrogen. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedure may be used until discharge at all blow out points is clean. Use 80-90 psig pressure unless otherwise indicated. Air blow cleaning shall require evacuation of all personnel not directly involved in the cleaning operation. Air blow shall apply to the following systems:

1. Instrument Air
2. Compressed Air

J. Following flushing or blowing operations, all items disconnected or blanked off shall be reconnected. Strainer screens shall be removed, cleaned and replaced.

K. Repeat cleaning as required to obtain a contamination-free system.

3.10 DISINFECTION – DOMESTIC WATER PIPING

A. Complete disinfection of new domestic cold, soft, and hot water piping and parts of existing systems that have been altered, extended, or repaired before use.

B. Contractor shall ensure internal surfaces of water lines are clean and free of foreign matter.

C. Water lines shall be completely separated from operating water system for disinfection purposes.

D. Advise Construction Representative at least 72 hours prior to flushing and disinfection of water lines.

E. Clean, disinfect, flush, and test all domestic potable water systems for bacteriological contamination before the system is put into operation, in accordance with the requirements of the Missouri Department of Natural Resources and International Plumbing Code.

F. Draw water samples and complete bacteriological testing by a testing facility which is certified for such testing by the Missouri Department of Natural Resources and approved by the Construction Representative.

G. Repeat cleaning and disinfection procedures if bacteriological testing indicates contamination.

H. Placed systems into operation only after testing shows the absence of bacteriological contamination and approved by Owner's Representative.

3.11 DISINFECTION – PROCESS WATER PIPING

A. Completed disinfection of new process soft, process hot water, and reverse osmosis piping and parts of existing systems that have been altered, extended, or repaired before use.

1. Disinfection of non-potable water systems is required to minimize the potential for biological contamination of non-potable water systems.

B. Contractor shall ensure internal surfaces of water lines are clean and free of foreign matter.

C. Water lines shall be completely separated from operating water system for disinfection purposes.

D. Advise Construction Representative at least 72 hours prior to flushing and disinfection of water lines.

E. Clean, disinfect, flush, and test all non-potable water systems for bacteriological contamination before the system is put into operation, in accordance with the requirements of the Missouri Department of Natural Resources and International Plumbing Code.

F. Draw water samples and complete bacteriological testing by a testing facility which is certified for such testing by the Missouri Department of Natural Resources and approved by the Construction Representative.

G. Repeat cleaning and disinfection procedures if bacteriological testing indicates contamination.

H. Placed systems into operation only after testing shows the absence of bacteriological contamination and approved by Owner's Representative.

3.12 FINAL INSPECTION AND ADJUSTING

A. After each installation is completed, tested for leaks, cleaned and approved by the Owner's Representative, it shall be filled with the fluid it is to carry.

B. The Contractor shall then test each system in actual operation, operate all valves, safety devices and equipment which he has installed and make final adjustments to place the system in operation.

C. Such operation shall be demonstrated to the satisfaction of the Owner's Representative.

PIPING SPECIFICATION NO. 1

General Use: Domestic Hot Water (DHW)
Domestic Soft Water (DSW)
Process Hot Water (PHW)
Process Soft Water (PSW)

Fabrication: 2" and under: Threaded

2-1/2" and above: Welded and Flanged

Pipe: Seamless Carbon Steel, ASTM A53 or A106, Grade B,
Threaded: Schedule 80
Welded: Schedule 40

Fittings: 2" and under: ANSI Class 2000, forged steel screwed fittings, ASTM A105, ANSI B16.11.

2-1/2" and above: Standard butt welding carbon steel, ASTM A234, ANSI B16.9, elbows to be long radius unless otherwise called for.

Unions and Flanges:
Unions: ANSI Class 2000 forged steel, screwed, ASTM A105, ANSI B16.11.

Flanges: ANSI Class 150, forged steel welding neck, raised face, ASTM A105, ANSI B16.5, with surface finish suitable for the specified gasket.

Gaskets: Full face, 1/8", SBR rubber per ANSI/AWWA C111/A21.11, ANSI/NSF Standard 61 certified for contact with potable water.

Bolting: ASTM A307, Grade B, heavy hexagon carbon steel bolts with ASTM A194, Grade 2H heavy semi-finished hexagonal nuts.

Bolting Antisieze: FDA compliant and NSF registered H1 for incidental food contact, Chesterton 785 FG, or approved equal.

Notes:
1. Backing or chill rings are not allowed.
2. Butt weld root pass shall be by gas tungsten arc welding (GTAW).
3. Note pipe weld inspection requirements.
3. All materials contacting potable water shall be lead free.
4. Plumbing fittings and fixtures not in compliance with standards established in accordance with 42 U.S.C. 300g-6(e) (latest version) shall not be used.
5. When used with respect to pipes, pipes fittings, plumbing fittings, and fixtures, refers to pipes, pipe fittings, plumbing fittings, and fixtures containing not more than a weighted average of .25 percent (0.25%) lead.

PIPING SPECIFICATION NO. 2

General Use:	Pumped Condensate (PC)
Fabrication:	2" and under: Threaded 2-1/2" and above: Welded and Flanged
Pipe:	Seamless Carbon Steel, ASTM A53 or A106, Grade B, 2" and below: Schedule 80 2-1/2" and above: Schedule 80
Fittings:	2" and under: ANSI Class 2000, forged steel, screwed fittings. ASTM A105, ANSI B16.11. 2-1/2" and above: Extra heavy, butt welding carbon steel, ASTM A234, ANSI B16.9, elbows to be long radius unless otherwise called for.
Unions and Flanges:	Unions: ANSI Class 2000 forged steel, screwed, ASTM A105, ANSI B16.11. Flanges: ANSI Class 150, forged steel welding neck, raised face, ASTM A105, ANSI B16.5, with surface finish suitable for the specified gasket.
Gaskets:	Stainless alloy spiral wound gasket, Class 150, 0.175 inch thick, flexible graphite filler, carbon steel external ring, 304 stainless steel internal ring, Flexitallic CGI, 304 SS/"Flexicarb."
Bolting:	ASTM A193, Grade B7 alloy steel stud bolts, ASTM A194, Grade 2H heavy hex nuts.

Notes:

1. Backing or chill rings are not allowed.
2. Butt weld root pass shall be by gas tungsten arc welding (GTAW).
3. Note pipe weld inspection requirements.

PIPING SPECIFICATION NO. 3

General Use: Reverse Osmosis Water (RO)

Fabrication: 1-1/2" and under: Threaded
2" and above: Welded and flanged

Pipe: 2" and under: Seamless or ERW 316L stainless steel, ASTM A312-TP316L, Schedule 40
2-1/2" and above: Seamless or ERW 316L stainless steel, ASTM A312-TP316L, Schedule 10S

Fittings: 1-1/2" and under: 150 lb. 316L stainless steel screwed fittings, ASTM A351, ANSI B16.3
2": Butt welding, 316L stainless steel, standard weight, ASTM A403-WP316L, ANSI B16.9, elbows to be long radius unless otherwise called for.
2-1/2" and above: Butt welding, 316L stainless steel, Schedule 10S, ASTM A403-WP316L, ANSI B16.9, elbows to be long radius unless otherwise called for.

Purging: Maintain inert backing gas (argon/helium) purge on inside of piping during welding.

Unions and Flanges: Unions: Forged 316 stainless steel, integral seat, ASTM A182-F316, Class 3000, threaded

Flanges: ANSI Class 150, forged 316L stainless steel welding neck or slip on, ASTM A182-F316L, ANSI B16.5

Or

Flanges: ANSI Class 150, forged steel, galvanized, lap-joint (Van Stone), ASTM A105, ANSI B16.5, with stainless steel, schedule 10, Type A, stub ends, ASTM A312-TP316L, ANSI B16.9.

Gaskets: 1/8" EPDM

Bolting: ASTM A307, Grade B, heavy hexagon carbon steel bolts with ASTM A194, Grade 2H heavy semi-finished hexagonal nuts. Hot dipped galvanized.

Notes:

1. Backing or chill rings are not allowed.
2. Butt welds shall be by gas tungsten arc welding (GTAW) with inert gas (argon/helium) purge.
3. Note pipe weld inspection requirements.
4. Weld procedures shall maintain corrosion resistance in weld-affected zone equal to corrosion resistance of base material.
5. Provide dielectric connections at joints between stainless steel, carbon steel and copper piping materials.

PIPING SPECIFICATION NO. 4

General Use: Instrument Air (IA)
Compressed Air (CA)

Fabrication: 3/8" and under: Compression fittings
1/2" to 2": Brazed joint with threaded valves
2-1/2" to 4": Brazed joints with flanged valves

Pipe: 3/8" and under: Seamless copper tubing, ASTM B88 Type K, soft annealed in straight lengths

1/2" and above: Seamless copper tubing, ASTM B88, Type K, hard drawn

Fittings: 3/8" and under: Compression type, brass, "Swagelok" or Parker "A-lok"
1/2" and above: Wrought copper pressure fittings, ANSI B16.22,
Brazed type with AWS BCuP-5 (80 Cu, 15 Ag, 5 P) filler metal.

Purging: Maintain nitrogen purge on compressed air piping during brazing with dry, oil free nitrogen to prevent formation of scale within the tubing.

Unions and Flanges: Unions: Wrought copper/cast copper alloy

Flanges: Class 150 cast copper, sweat connection, ANSI B16.24, with surface finish suitable for the specified gasket.

Gaskets: 1/16" non-asbestos compressed gasket material, Chesterton 195, Garlock 3000, or equal

Bolting: ASTM A307, Grade B, heavy hexagon carbon steel bolts with ASTM A194, Grade 2 H heavy semi-finished hexagonal nuts.

Special Requirements:
Notes:

1. Note pipe weld inspection requirements.
2. Provide dielectric connections at joints between stainless steel, carbon steel and copper piping materials.
3. Copper pipe installation shall comply with the Copper Development Association, The Copper Tube Handbook.
4. Provide neat bends rather than fittings for tubing 3/8" and under wherever possible.
5. Protect non-metallic valve seats/seals from damage during soldering/brazing.

PIPING SPECIFICATION NO. 5

General Use: Chemical Feed (CF)
Instrument Tubing (IT)

Fabrication: 1" and under: Stainless steel tube with compression fittings.
1-1/2" and above: PVC, socket type.

Pipe: 1" and under: Stainless steel tubing, seamless, annealed, Type 316, ASTM A269, in O.D. sizes, 0.035" wall to 1/2", 0.065" wall to 1". Hardness of Rb80 or less.

1-1/2" and above: PVC Schedule 80, ASTM D1785.

Fittings: 1" and under: 316 stainless steel compression type, "Swagelok" or Parker "A-lok".

1-1/2" and above: PVC Schedule 80, socket type, solvent cement, ASTM D2467, D2564.

Flanges: 150 lb. PVC, ASTM D1784, Type 1, Grade 1, ANSI B16.5, flat face

Gaskets: Flat, full face, 1/8" thick EPDM

Bolting: ASTM A307, Grade B, carbon steel bolts with heavy semi-finished hexagon nuts.

PIPING SPECIFICATION NO. 6

General Use: RO Tank Vent (ROV)
RO Tank Drain (ROD)

Fabrication: Socket type, solvent weld

Pipe: PVC, Schedule 80, ASTM D1785, Type 1, Grade 1 PVC, ASTM D1784

Fittings: PVC Schedule 80, molded, socket type, solvent cement, ASTM D2467, D1784

Flanges: ANSI Class 150, PVC, ASTM D1784, Type 1, Grade 1, ANSI B16.5, flat face

Gaskets: Full face, 1/8" thick EPDM

Bolting: Stainless steel bolts, nuts, and washers.

Notes:

1. Materials shall be NSF-61 certified.
2. All piping and components shall have a minimum pressure rating of 150 psig at 120°F.

END OF SECTION 232000

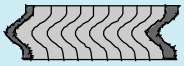
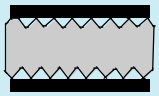
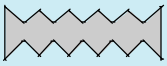
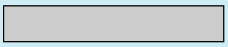
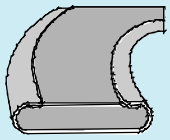
Gasket Installation

For critical applications a more sophisticated method for bolt up may be considered such as heating rods, bolt tensioners, or ultrasonic extensometer.

Bolting Up Sequence

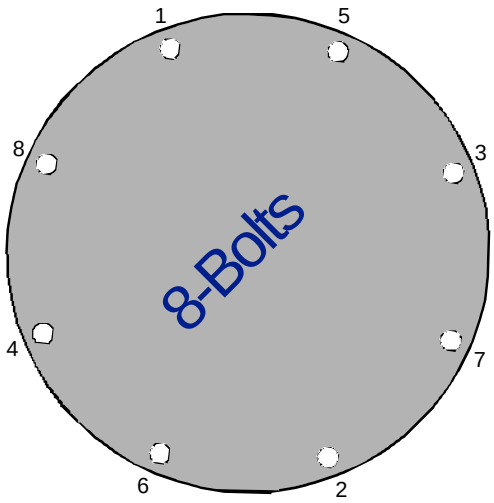
Stage 1 - Torque bolts up to approximately 30% of the final torque value following the diametrically opposed sequence specified in table on page 56.
Stage 2 - Repeat Stage 1, increasing the torque value to approximately 60% of the final torque value.
Stage 3 - Repeat Stage 2, increasing the torque value to the final required torque value.
Stage 4 - A final tightening should be performed following an adjacent bolt-to-bolt sequence to ensure that all bolts have been evenly stressed.
Note: See Page 46 for bolt torque sequence.

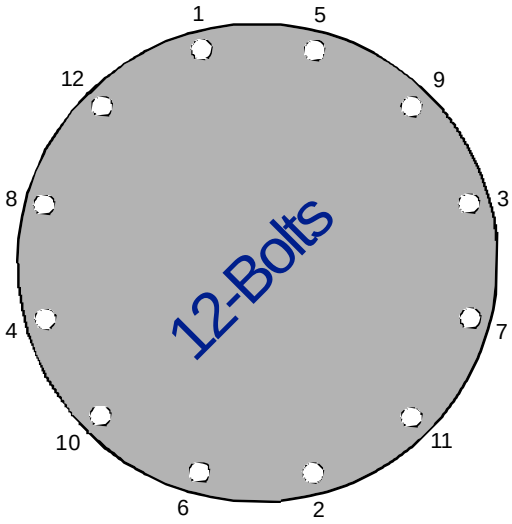
Surface Finish Requirements

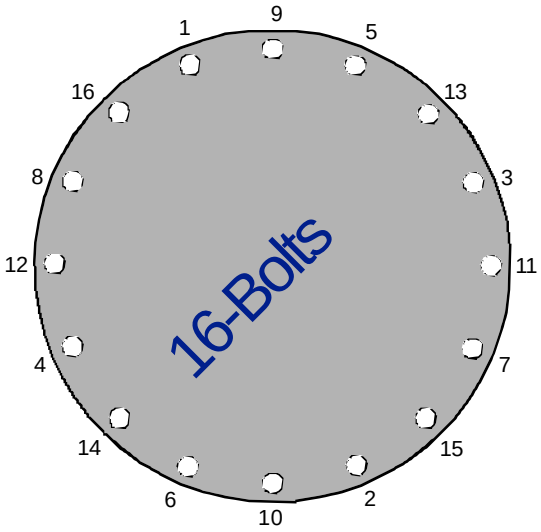
Gasket Description	Gasket Cross Section	Flange Surface Finish Microinch RMS	Flange Surface Finish Micrometer Ra
Spiral Wound Gaskets		125 - 250	3.2 - 6.3
Flexpro Gaskets		125 - 250	3.2 - 6.3
Metallic Serrated Gaskets		63 MAX	1.6 MAX
MRG		125 - 250	3.2 - 6.3
Solid Metal Gaskets		63 MAX	1.6 MAX
Metal Jacketed Gaskets		100 - 125	2.5 MAX
Soft Cut Sheet Gaskets		Mat'l < 1.5MM Thick 125 - 250	Mat'l < 1.5mm Thick 3.2 - 6.3
		Mat'l ≥ 1.5mm Thick 125 - 500	Mat'l ≥ 1.5mm Thick 3.2 - 12.5

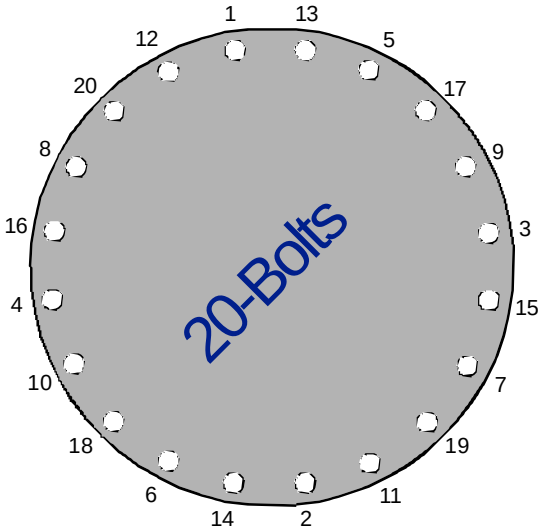
Important - Under no circumstances should flange sealing surfaces be machined in a manner that tool marks would extend radially across the sealing surface. Such tool marks are practically impossible to seal regardless of the type of gasket used.

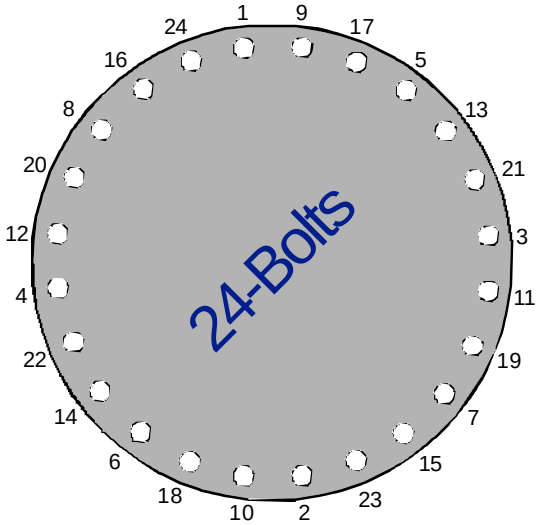
Bolt Torque Sequence











Torque Required To Produce Bolt Stress

The torque or turning effort required to produce a certain stress in bolting is dependent upon a number of conditions, some of which are:

1. Diameter of bolt
2. Type and number of threads on bolt
3. Material of bolt
4. Condition of nut bearing surfaces
5. Lubrication of bolt threads and nut bearing surfaces

Generally, standard FLEXITALLIC spiral wound gaskets will require that bolting is stressed to 30,000 psi for proper gasket seating. However, it is a common industry practice to apply a bolt stress equivalent to 50% of yield of commonly used alloy steel bolts, (A 193 B7), to seat standard spiral wound gaskets. The applied force provides for some compensation in bolt up inconsistencies, creep relaxation, and other variables associated with flange make up.

Torque Data For Use with Alloy Steel Stud Bolts

Load in Pounds on Stud Bolts When Torque Loads Are Applied

Nominal Diameter of Bolt (Inches)	Number of Threads (Per Inch)	Diameter at Root of Thread (Inches)	Area at Root of Thread Sq. Inch	Stress					
				30,000 psi		45,000 psi		60,000 psi	
				Torque Ft/Lbs	Load Lbs	Torque Ft/Lbs	Load Lbs	Torque Ft/Lbs	Load Lbs
1/4	20	.185	.027	4	810	6	1215	8	1620
5/16	18	.240	.045	8	1350	12	2025	16	2700
3/8	16	.294	.068	12	2040	18	3060	24	4080
7/16	14	.345	.093	20	2790	30	4185	40	5580
1/2	13	.400	.126	30	3780	45	5670	60	7560
9/16	12	.454	.162	45	4860	68	7290	90	9720
5/8	11	.507	.202	60	6060	90	9090	120	12120
3/4	10	.620	.302	100	9060	150	13590	200	18120
7/8	9	.731	.419	160	12570	240	18855	320	25140
1	8	.838	.551	245	16530	368	24795	490	33060
1-1/8	8	.963	.728	355	21840	533	32760	710	43680
1-1/4	8	1.088	.929	500	27870	750	41805	1000	55740
1-3/8	8	1.213	1.155	680	34650	1020	51975	1360	69300
1-1/2	8	1.338	1.405	800	42150	1200	63225	1600	84300
1-5/8	8	1.463	1.680	1100	50400	1650	75600	2200	100800
1-3/4	8	1.588	1.980	1500	59400	2250	89100	3000	118800
1-7/8	8	1.713	2.304	2000	69120	3000	103680	4000	138240
2	8	1.838	2.652	2200	79560	3300	119340	4400	159120
2-1//4	8	2.088	3.423	3180	102690	4770	154035	6360	205380
2-1/2	8	2.338	4.292	4400	128760	6600	193140	8800	257520
2-3/4	8	2.588	5.259	5920	157770	8880	236655	11840	315540
3	8	2.838	6.324	7720	189720	11580	284580	15440	379440
3-1/4	8	3.088	7.490	10000	224700	15000	337050	20000	449400
3-1/2	8	3.338	8.750	12500	262500	18750	393750	25000	525000
3-3/4	8	3.589	10.11	15400	303300	23150	454950	30900	606600

Note: Torque values are based on well lubricated alloy steel bolting.

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SECTION 232116 – PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

A. Contractor shall furnish and install all piping specialties as shown on the Drawings and specified herein.

1.3 SUBMITTALS

A. Manufacturer's data sheets, material source certifications, material test reports.

B. Performance Curves

C. Motor Data

D. Wiring Diagrams

E. Factory Test Reports

F. Factory Calibration Reports

G. Field Calibration Reports

H. Field Inspection Reports

1.4 QUALITY CONTROL

A. Instruments shall be factory calibrated with devices traceable to the National Institute of Standards and Technology (NIST).

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Pressure gauges shall be furnished and installed as called for on the Drawings.

B. Pressure gauges shall be 1/2% accuracy with stainless steel movement, black polypropylene or aluminum alloy case, 4-1/2" diameter dial, solid front, blowout back, and 1/2" NPT connection. Gauges shall be Ashcroft, Trerice, Weiss, Weksler, Miljoco, or Palmer.

C. Unless otherwise warranted by the service requirements, bourdon tube shall be:

1. Bronze for copper pipe.
2. Bronze for carbon steel pipe with service temperatures less than 150^{o}F.
3. Stainless steel for carbon steel pipe with service temperatures above 150^{o}F.
4. Stainless steel for stainless steel pipe.

D. Unless otherwise noted, all gauges shall have ½" bar stock needle valve with hard faced seats, blow-out proof stem, PTFE or graphite/graphoil packing, suitable for the service fluid, pressure, and temperature, Hex Valve, or approved equal. Valve material shall be equivalent to associated pipe material.

E. Outdoor gauges shall be liquid filled with silicone suitable for -40°F to +150°F ambient.

F. Gages used on pumps shall have pressure snubber to dampen pulsations.

G. Gauges used on pumped condensate service shall be protected with pigtail siphons and primed with clean water prior to start-up.

H. Pressure gauges shall be as follows. Quantities shall be determined by the drawings.

Tag	Service	Service Pressure (psig)	Service Temperature (°F)	Scale (psig)
PI-1	DSW, PSW, DHW, PHW	60 - 80	50 - 70	0 - 160
PI-2	RO	30 - 80	50 - 70	0 - 160
PI-3	PC	30-80	160 - 200	0 - 160

2.2 THERMOMETERS

A. Thermometers shall be furnished and installed as called for on the Drawings.

B. Thermometers shall be the hermetically sealed bimetallic type with 1% full span accuracy, ½" NPT connection stainless steel case, external adjustment and "every angle" feature. Thermometers shall have 3" dial and be furnished with separable brass thermowell.

1. Thermowell shall have ¾" process connection and extended neck as required for use on insulated pipe.
2. Stem of thermometer and length of thermowell shall extend to the center of the pipe or a minimum of 4" into the pipe.
3. Furnish heat transfer gel with thermometers.

C. Thermometers shall be Aschroft "EI," Palmer "Model 5A," Trerice "B856 Series," Weiss "Model 5VBM," or Weksler "Type AF."

D. Thermometer scale range shall be as follows:

1. TI-1: Process Soft Water: 0 to 100° F.

2.3 STRAINERS

A. Furnish and install strainers as shown on the Drawings. Unless otherwise indicated or specified, strainer shall be Y-pattern with 316 stainless steel perforated screen having .045" openings.

B. Strainers shall be as follows:

1. ST-1: Flanged, 150 lb., cast carbon steel, ASTM A216 Grade WCB, Armstrong B1FL-CL150 or approved equal.

2. ST-2: Flanged, 150 lb., cast 316 stainless steel, ASTM A351 Grade CF8M, Armstrong E7FL-CL150 or approved equal.

2.4 BACKFLOW PREVENTER

A. Reduced pressure backflow preventer assembly (ASSE 1013) shall be a complete unit consisting of two spring-loaded check valves, a spring-loaded, diaphragm actuated differential pressure relief valve with air-gap fitting located in the zone between the check valves, OS&Y resilient seat gate valves on inlet and outlet, inlet strainer, and test cocks.

B. Units shall conform to ASSE or AWWA Standards, and shall be UL listed.

C. Backflow preventers shall be approved by Missouri Department of Natural Resources, and comply with Missouri Title 10, DNR, Division 60, Public Drinking Water Program, Chapter 11.

D. All materials shall be corrosion resistant and where ferrous metals are used they shall be protected against corrosion with AWWA C550 or FDA approved epoxy lining.

E. The assembly shall be rated for 175 psi.

F. Maximum pressure drop shall be 10 psi through middle one-third of flow range.

G. Units 2" and under shall have threaded end connections. Units 2-1/2" and larger shall be flanged.

H. Backflow preventers shall be as follows. Quantities shall be determined by the drawings.

Tag	Service	Service Pressure (psig)	Service Temperature (°F)	Design Flow (gpm)	Pressure Drop at Design Flow (psi)
BFP-1	DSW, PSW	60 - 80	50 - 70	200	10
BFP-2	DHW, PHW	60 - 80	100 - 120	80	15

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping specialties in full accordance with manufacturer's instructions.

3.2 INSTRUMENTS

A. Field check instrument calibration with devices traceable to National Institute of Standards and Technology (NIST).

B. Gauges shall be installed so as to be visible from adjacent walkways, platforms, etc.

C. Thermowell shall be filled with heat transfer gel prior to inserting thermometer stem.

D. For thermometers in pipe diameters 2" or less, install a minimum 2-1/2" x 2-1/2" tee with appropriate bushings, reducers, nipples, etc., in the line pipe.

1. Install the well into the tee with appropriate bushing nipples, caps. etc., as required to obtain thermowell insertion to pipe centerline without causing a flow restriction.

3.3 BACKFLOW PREVENTERS

A. Install in accessible location no more than 4’ above top of finished floor or platform.

B. Install relief drain piping with air gap to floor drain.

END OF SECTION 232016

SECTION 232519.16 – REVERSE OSMOSIS WATER TREATMENT EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install a reverse osmosis water treatment system as shown on the Drawings and specified herein.

1.3 GENERAL

A. Provide complete, industrial grade, factory-packaged, fully integrated and automated, reverse osmosis (RO) water treatment system producing high purity water by removal of dissolved minerals, bacteria, particles and organic impurities.

B. The reverse osmosis water treatment system will provide makeup water to the Power Plant's deaerator and boiler feedwater system.

C. RO permeate will supply one atmospheric RO water storage tank and be pumped from there to a deaerating feedwater heater serving three, 1,000 hp fire tube boilers, which generate saturated steam at about 125 psig.

1. The power plant’s firm steam capacity is 67,970 lb/hr with a deaerator rated for about 77,000 lb/hr.
2. Plant steam load varies with ambient weather conditions and correctional center process steam loads.
    a. Peak steam load is about 40,000 lb/hr.
    b. Average steam load is about 10,000 lb/hr.
    c. Typical minimum steam load is about 4,000 lb/hr.
3. Under "normal" operation, the condensate return is about 70%.
4. Assuming 2% continuous blowdown, the makeup water demand ranges from about 3 gpm to 26 gpm, with an average of about 7 gpm. Make-up water demand at the plant’s firm steam capacity is about 44 gpm.
5. Under "abnormal" operation (40% condensate return at peak steam load), the makeup water demand is about 50 gpm.

D. The RO water treatment system shall include, but not be limited to:

1. An RO unit factory-mounted on a skid with influent prefilter, booster pump, RO membranes and housings, piping, instrumentation, controls, accessories, wiring, etc., which requires only final connections to made prior to start-up.
2. Provision for dechlorination, anti-scalant, inlet pH control, and permeate pH control chemical feed systems.
3. Provisions for cleaning the RO membranes in-place.
4. Coordination and integration of RO equipment with the RO water storage system,
5. Coordination and integration with the RO water pump system.

E. The RO system shall be designed for continuous and intermittent automatic operation.

F. All pressurized vessels (prefilter, membrane vessels, etc.) shall be designed and fabricated in accordance with the appropriate ASME Code.

G. Piping shall be fabricated and installed in accordance with the Code for Pressure Piping, ANSI B31.1 (Latest) "Power Piping".

H. Equipment size shall be coordinated with the available space and available access for installation.

1.4 RELATED SECTIONS

A. Section 230501 - General Mechanical Requirements for HVAC

B. Section 230513 - Common Motor Requirements for HVAC Equipment

C. Section 230515 – Variable-Frequency Motor Controllers

D. Section 232519.20 – Reverse Osmosis Water Treatment System Controls

E. Section 232519.30 – Reverse Osmosis Water Storage Tank

F. Section 232519.40 – Reverse Osmosis Water Pumping System

1.5 APPLICABLE PUBLICATIONS

A. The latest edition of the publications listed below form a part of this specification to the extent applicable. The publications are referenced in the text by their basic designation only.

B. American Society of Mechanical Engineers (ASME):

1. B40.100, Pressure Gauges and Gauge Attachments

C. ASTM International (ASTM):

1. A269/A269M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
2. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D. American Water Works Association (AWWA):

1. B300, Hypochlorites
2. B301, Liquid Chlorine
3. C651, Disinfecting Water Mains

E. National Electrical Manufacturers Association (NEMA):

1. ICS 6, Industrial Control and Systems Enclosures

F. National Fire Protection Association (NFPA):

1. 70, National Electrical Code

G. Department of Health and Human Services, Food and Drug Administration (FDA):

1. CFR 21, Chapter 1, Part 175.300, Resinous and Polymeric Coatings

1.6 SUBMITTALS

A. RO system manufacturer's test results on influent water.

B. Manufacturer's literature, data, and shop drawings including, but not limited to:

1. Full item description including optional features and accessories, materials, standards compliance, model numbers, size, and capacity.
2. Equipment general arrangement to include sizes, dimensions, weights, connection points, design parameters, array, type and quantity of RO elements, square feet of membrane surface, required maintenance clearance, skid painting, etc.
3. Catalog data, data sheets, and pump curve for booster pump.
4. Catalog data, nameplate data and outline drawing for booster pump motor.
5. Catalog data and installation, operation and maintenance instructions for motor shaft grounding device.
6. Product data sheets and shop drawings for variable-frequency motor controller.
7. Piping and instrumentation diagram (P&ID). Include indication of devices tubed/wired to local control panels.
8. Material list and catalog data for instrumentation, valves, controls, trim items, accessories etc. Coordinated with P&ID.
9. Piping specifications.
10. Wiring diagrams.
11. Control panel layouts.
12. Sequence of operations.
13. Performance data including normal and maximum flow and pressure drop.
14. Year 0 and end of year 3 water quality projections at both high and low inlet water temperatures using membrane manufacturer's computerized water quality projection program.
15. Certification that required performance shall be achieved.

C. Installation manuals.

D. Operation and maintenance manuals including:

1. All aspects of system operation.
2. Maintenance procedures
3. Piping isometrics
4. Wiring diagrams of all circuits
5. Written description of system design
6. Control logic
7. Sequence of operation
8. Troubleshooting techniques
9. Procedures for emergency situations.
10. List of recommended spare parts (manufacturer, model number, and quantity)
11. Information explaining any special knowledge or tools the owner will be required to employ.

E. Training plan and instructor qualifications.

F. Factory test results.

G. Field test results.

1.7 QUALITY ASSURANCE

A. Manufacturer shall have been engaged in the manufacture of RO systems as a primary product for at least ten years. The ten year requirement supersedes any conflicting requirement in other parts of the project specification.

1.8 PROJECT CONDITIONS

A. Influent Water Analysis:

1. The RO influent water is softened well water.
2. An influent water analysis of the softened well water is included in Attachment A to this Section for bid purposes.
3. A general water quality report for the well water prior to the softeners is included in Attachment B.
4. Maximum Silt Density Index (SDI) Rating was tested at 0.34.
5. Prior to proceeding with RO system design, the RO system manufacturer shall obtain current water samples and complete all influent water tests necessary to properly design the RO system.

    a. At a minimum, testing shall comply with ASTM D4195, Standard Guide for Water Analysis for Reverse Osmosis and Nanofiltration Application (latest edition).

1.9 DESIGN BASIS

A. The design basis for the Reverse Osmosis Water Treatment System shall be as follows.

1.	Tag:	RO-01
2.	Configuration:	Single Pass, Multi-Stage[1]
3.	Approximate RO Skid Size	146” Long x 40” Wide x 96” High
4.	RO Permeate (Product) Flow:	50 gpm, 72,000 gallon per day at 40^{o}F
5.	Minimum RO Permeate Recovery:	75% of Feedwater Flow
6.	Minimum Rejection Ratio:	99% of Feedwater TDS
7.	Maximum Feedwater TDS:	500 mg/liter
8.	Feedwater Temperature Range:	40^{o}F to 85^{o}F
9.	Maximum RO Permeate Flux:	16 gallons/ft^{2}/day
10.	Typical Daily RO Water Usage:	4,000 to 40,000 gallons per day, Average of 10,000 gallons per day
11.	RO Feedwater Supply Pressure:	20 psig – 80 psig (50 -60 psig typical)
12.	RO Permeate Outlet Pressure:	10 psig
13.	RO Flush Water Pressure:	30 psig to 50 psig.

[1]Anticipated configuration.

B. The array shown on P&ID drawing, is for illustrative purposes only. Manufacturer shall determine array subject to Specification compliance and Designer’s approval.

1.10 GUARANTEEES

A. The RO membrane elements shall be guaranteed against failure from physical defects for a period of three (3) years from startup on a non-prorated basis.

B. RO permeate water quality shall be guaranteed as follows over the feedwater temperature range at the end of the third year of operation with maximum 25% RO concentrate flow.

		Maximum Concentration
1.	Silica as SiO2	0.5 ppm
2.	Total Alkalinity as CaCO3	11.0 ppm
3.	Total dissolved solids as ions	14.0 ppm

C. If the guaranteed performance is not met, the Contractor shall make the necessary corrections to bring the performance into compliance and shall pay for the additional testing to verify compliance.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications and Drawings, the Reverse Osmosis Water Treatment System shall be heavy duty, industrial type, manufactured by one of the following, or approved equal:

1. Axeon
2. Evoqua
3. H&H Water, Inc.
4. SAMCO
5. Walter Louis Fluid Technologies

2.2 REVERSE OSMOSIS (RO) WATER TREATMENT SYSTEM

A. Provide a factory-packaged, factory-tested, fully automated, RO system mounted on steel frame, designed for the project conditions.

B. Equipment shall be arranged on the frame to allow easy access for operation, maintenance, and repair.

C. RO system shall include, but not be limited to, RO membrane, pressure vessels, prefilter, feedwater booster pump with variable frequency drive (VFD) and all required piping, instrumentation, wiring and controls for a fully operational system.

D. RO Membrane Elements: Thin-film composite, spiral wound, with fiberglass reinforced polyester (FRP) over-wrap, anti-telescoping devices, interconnectors, and u-cup brine seal.

1. With salt rejection capability of no less than 98 percent based on 2000 ppm water at 225 psig at 77 degrees F.
2. Membrane make and model shall have been in successful use in equivalent industrial applications for no less than 5 years.
3. Membrane elements shall be shipped loose in the original manufacturer’s packing to ensure elements are protected from physical damage and biological contamination during shipment.

E. RO Membrane Element Housings:

1. Fiberglass reinforced plastic (FRP) or 316L stainless steel with minimum 300 psig working pressure rating.
2. Stainless steel side ports for feed and concentrate connections to facilitate membrane removal.
3. PVC end caps held in place with stainless steel retainers.
4. Vessel shall be straight with consistent internal dimensions, O-rings, and O-ring lubricant as required to facilitate membrane placement and removal and prevent feedwater bypassing of membranes.
5. NSF-61 rated.

F. Prefilter

1. Multi-cartridge filter sized for the RO feedwater flow rate and sized to minimize pressure drop.
2. Filter: Designed for suspended solids removal down to 5 microns, polypropylene type. String wound filters are not acceptable.
3. Cartridge Housing: 316L stainless steel with minimum 150 psig working pressure rating, with vent and drain valves.
4. Seals: As required to prevent water from bypassing filter elements.

G. Booster Pump and Motor:

1. Provide skid-mounted, motor driven, booster pump to increase the pressure of the RO feedwater to a suitable operating pressure.
2. Adequate margins shall be included in the pump design to compensate for normal membrane pressure drop increase over the life of the membranes and maintain design flow at lowest temperature.
3. Pump shall be of corrosion resistant with materials, construction, and pressure and temperature ratings suitable for the service conditions.
4. Single
5. Vertical, multistage, high efficiency, centrifugal type
6. Type 316 stainless steel casing, shaft, impellers, trim, with flanged piping connections.
7. Tungsten carbide and ceramic shaft seals.
8. Premium efficiency, TEFC motor, for use with variable frequency motor controller complying with Section 230513 - Common Motor Requirements for HVAC Equipment.
    a. Selected to be non-overloading on the entire performance curve
    b. 230/460 VAC, 3 phase, 60 Hz
    c. Maximum 20 hp
9. Provide a skid mounted variable frequency drive (VFD) complying with the requirements of Section 230515 – Variable-Frequency Motor Controllers.

H. Manual Valves:

1. Provide all manual valves necessary to properly operate, maintain, clean, test and isolate the RO unit, with material, construction, and pressure and temperature ratings suitable for the service conditions, including, but not limited to, the following.
2. Valves for Low Pressure Feed, Reject, Permeate and Recycle Piping (100 psig and under):

a. PVC construction or 316 stainless construction.

3. Valves for High Pressure Feed, Reject, Permeate, and Recycle Piping (above 100 psig): 316 stainless steel construction.
4. Process Soft Water Inlet Isolation Valve: Ductile iron butterfly with 316 stainless steel disk and trim and EPDM seats and seals.
5. Permeate Outlet Isolation Valve: Ductile iron butterfly with 316 stainless steel disk and trim and EPDM seats and seals.
6. Booster Pump Throttle Valve: Globe or ball valve.
7. Concentrate Throttle Valve: Needle style.
8. Recycle Throttle Valve: Needle style.
9. Booster Pump Check Valve: EPDM seats and seals.
10. Permeate Check Valve: EPDM seats and seals.
11. Concentrate Check Valve: EPDM seats and seals.
12. RO Flush Isolation Valve: Ball valve.
13. RO Flush Check Valve: EPDM seats and seals.
14. Feedwater Sample Valve: Plug or ball valve with EPDM seats and seals.
15. Cartridge Filter Outlet Sample Valve: Plug or ball valve with EPDM seats and seals.
16. Permeate Water Sample Valves: Plug or ball valve with EPDM seats and seals, for each membrane vessel.
17. Concentrate Sample Valve: Plug or ball valve with EPDM seats and seals.
18. Permeate Relief Valve: 316 stainless steel with EPDM seats and seals.
19. Feedwater Bypass Isolation Valves: Ductile iron butterfly with 316 stainless steel disk and trim and EPDM seats and seals.
20. Feedwater Bypass Manual Valve: Type 316 stainless steel, ball valve.
21. Feedwater Bypass Check Valve: Type 316 stainless steel with EPDM seats and seals.
22. CIP Isolation Valves: Ball valve.
23. Valves as required for vents, drains, instrumentation, and controls.

I. Automatic Valves:

1. Provide all automatic valves necessary to properly operate, maintain, clean, test and isolate the RO unit, with material, construction, and pressure and temperature ratings suitable for the service conditions.
2. Automated valves shall include, but not limited to, the following.
   a. Feedwater isolation valve
   b. Membrane flush valve
      1) Provide for purging the membranes with fresh water upon machine shut down.
   c. Concentrate flush bypass valve
   d. Permeate dump valve
   e. Permeate isolation valve
   f. Feedwater bypass valve.
3. Automatic valves shall be ball or butterfly type with electric actuators.
4. Ball Valves shall be 316 stainless steel body and trim with PTFE seats and seals.
5. Butterfly Valves shall be lug type, ductile iron body with 316 stainless steel disc and trim, and EPDM seat/liner.
6. Electric Actuators shall be totally enclosed, non-ventilated, high starting torque, brushless, split phase capacitor, start/run reversing AC motor with:
   a. Thermal Overload Motor Protection
   b. Heater
   c. Mechanical brake

d. 120 VAC, 60 Hz power supply
e. 4-20 mADC positioner with position feedback for modulating service
f. Open/closed position switches for two-position service
g. Ambient temperature range: -31 to 250 degrees F
h. Permanently lubricated gear train
i. Bearings: High quality alloy steel sleeve and ball bearings
j. Housing: NEMA 4, corrosion-resistant, aluminum die cast
k. Visual position indicator
l. Manual override handle
m. Adjustable mechanical stops

J. Piping:

1. All interconnecting piping and tubing shall be provided such that only a single point field connection is required to each RO skid for feedwater, permeate, concentrate, RO water flush, and compressed air for cleaning.
   a. Provide flanges or unions at skid equipment connections to facilitate removal of equipment.
2. Provide piping and valves as required for cleaning the membranes and housings.
   a. Connection points for cleaning piping shall have Victaulic couplings and caps.
3. Provide automatic bypass "flushing" valve and piping around RO concentrate control valve to permit flushing during startup and shutdown.
4. Provide automatic "bypass" valve and piping around RO unit to permit feedwater bypass of RO unit on low RO tank level.
5. Low Pressure Feed, Reject, Permeate and Recycle Piping (100 psig and under):
   a. PVC or stainless steel per pipe specifications at the end of this specification section.
6. High Pressure Feed, Reject, Permeate, and Recycle Piping (above 100 psig): Stainless steel per pipe specifications at the end of this specification section.
7. Instrumentation and Compress Air: Stainless steel tubing per pipe specifications at the end of this specification section.
8. Low Pressure Control and Pressure Gage Tubing: Polyethylene.
9. High Pressure Control and Pressure Gage Tubing: 1000 psig burst nylon.

K. Chemical Feed Systems:

1. Provide provisions including pipe connections, injection quills with integral check valve, static mixers, sensors, control loops, and 4-20 mADC or on/off control signals for dechlorination (sodium bisulfite), antiscalant, and pH control (NaOH & acid) chemical feed systems.

2. Chemical tanks and metering pumps will be furnished by Owner’s water treatment consultant for Contractor installation.

L. Instrumentation & Controls:

1. Provide a fully integrated and automated RO instrumentation and control system in accordance with Section 232519.20 – Reverse Osmosis Water Treatment System Controls which includes, but is not limited to, the following.
   a. PLC controller providing automatic control for all operating functions.
   b. Touch Screen Human Machine Interface
   c. NEMA 4 enclosure(s).

d. Factory wiring
e. Factory installed on RO skid and tested.

2. Comply with NFPA 70 and Division 26 requirements, unless approved otherwise by Engineer.
3. Control system shall include, but not be limited to, the following:
   a. Emergency stop push button.
   b. Isolation of unit when removed from service.
   c. RO water tank level monitoring and indication.
   d. RO unit stop/start based upon RO water tank level.
   e. Feedwater bypass start/stop on low RO tank level.
   f. Capability for future automatic alternating of multiple RO units.
   g. Flushing on startup.
   h. Dump of permeate on startup.
   i. Flushing of unit at shut down.
   j. Flushing at adjustable intervals when unit is not operating for extended periods.
   k. Manual start/stop of RO unit with permeate flow selection to RO tank or drain.
   l. Manual flushing.
   m. Manual dump of permeate.
   n. Control valve position monitoring.
      1) Open/Closed position monitoring for two position valves.
      2) Continuous position monitoring for modulating valves.
   o. RO water tank level monitoring:
      1) Continuous level monitoring
      2) High level RO shutoff – 6” below overflow
      3) High high level shutoff and alarm – 3” below overflow
      4) Low level RO start-up – 24” below overflow
      5) Low low level RO bypass and alarm – 48” below overflow
      6) Low low low level alarm – 54” below overflow
   p. Feedwater monitoring and control:
      1) Temperature
      2) Low pressure
      3) pH
      4) Conductivity
      5) Free chlorine/Oxygen-reduction potential
      6) Filter differential pressure
   q. Booster pump monitoring and control:
      1) Discharge pressure
      2) High pressure
      3) Motor speed
   r. Permeate monitoring and control:
      1) Flow
      2) Conductivity
      3) pH
      4) High pressure
   s. Concentrate monitoring and control:
      1) Flow to drain
      2) Flow to recycle.
   t. Chemical feed pump control:
      1) Include control capabilities for anti-scalant, dechorination, caustic, and acid chemical feed systems as indicated on the Drawings.

2) Chemical feed systems will be furnished by Owner's water treatment service provider.
3) Coordinate as required.

u. Setpoint indication, status indication, low limit alarm, and high limit alarms for all monitored process variables.

v. Safety switches, automatic shutdown, and alarms as required for personnel and equipment protection, with first out indication, and manual reset.

w. Miscellaneous controls shall include, but not be limited to:
1) Elapsed run time indicator
2) Event history
3) Process variable trending
4) RO element remaining life projection
5) Alarm horn with alarm silence push button
6) Convenience receptacle
7) Minimum 8 auxiliary contacts 2DI, 2DO, 2AI, 2AO.

M. RO Tank Level Instrumentation: Provide float type magnetic liquid level gauge (gas/liquid interface) with externally mounted level transmitter and level switches, coordinated and integrated with RO water storage tank.

1. Minimum Pressure/Temperature Rating: 30 psig at 120 F.
2. External magnetic indicator, high visibility red and silver aluminum flags, magnetically interlocked with float, mechanical stops to allow only 180 degree rotation, graduated in feet and inches, stainless steel housing with glass indicator window.
   a. Resolution: +/- 0.25".
   b. Measuring Range: Coordinate with tank manufacturer, subject to Designer's approval.
   c. Mounting: Coordinate with tank manufacturer, subject to Designer's approval.
3. Float: Internal, 360 degree magnet, 316L stainless steel, suitable for applications to 100 psig at temperatures from 40 F to 300 F.
4. Chamber: 2 ½", Schedule 40, 316L stainless steel, with top and bottom raised-face slip-on flanges, composition gaskets, with ½" 3000 lb FNPT drain and vent connections, adjustable support clips.
   a. With suitable drain valve with plug.
   b. With vent plug.
   c. With bottom clearance sufficient for float removal.
5. Process connections: Flanged, side-mounted, 1½", Schedule 40, 316L stainless steel.
6. Level Transmitter: External mounted magnetostrictive type.
   a. Top mount.
   b. Measuring Range: 60".
   c. Sensor: 316 stainless steel, 5/8" diameter probe, 316 stainless steel mounting brackets, suitable for -200 F to 750 F operating temperature
   d. Housing: Epoxy coated aluminum alloy or stainless steel, NEMA 4X, 1/2" NPT conduit connection, and single terminal block.
   e. Local Indication: Integral 5 digit LCD.
   f. Output: two wire, 4-20 mADC and HART "smart" digital communication
   g. Power Supply: 12-42 VDC loop powered
   h. Resolution: +/- 0.25".
   i. Stability: +/- 0.15% of upper range limit over 10 years
7. Level Switches: External mounted, clamped to chamber, adjustable, magnetically actuated type, with NEMA 4 enclosure.
   a. Suitable deadband to eliminate chattering.
8. Welding and welder qualifications in accordance with ASME Section IX.

9. Factory hydrostatic test to minimum 100 psig.
10. Factory tested and calibrated.
11. Stainless steel name tag
12. Manufactured to ASME B31.1, ANSI/ASME B16.5 Class 150
13. Manufacturers: Magtech LG/LTM Series, or approved equal by ABB, Babbit, Magnetrol, Bliss, Penberthy.

N. Pressure Gauges:

1. Provide pressure gages for filter differential pressure, booster pump inlet, booster pump discharge, RO feed, RO interstage and final concentrate, and RO product.

O. Communications Interface:

1. Provide a communications interface between the new RO control system and the existing power plant building automation system (Automated Logic).
   a. Provide RO system displays with all available RO system data, alarms, event history, etc. on the existing power plant operator interface station.
   b. Duplicate the RO system operator interface screens on the power plant's operator interface station to the extent possible.
   c. Provide critical RO system data collection, trending, and archiving to the power plant work station.
   d. Remote RO system control from the power plant operator interface station is not required, but shall be a capability for future consideration.
   e. Communication interface shall be BACnet (which is preferred) or Modbus with hardwire MSTP or TCP/IP protocol. Field verify.
2. The existing power plant control system was installed and has been serviced by Premium Mechanical & Automation (573-243-3918, Randy Henley, Don Henley).

P. Skid and Frame Assembly: RO equipment shall be built on a skid and frame constructed of welded structural carbon steel. The entire surface shall be sand-blasted and coated with a corrosion and abrasion resistant, high solids, epoxy coating.

Q. Reassembly: Unit shall be shipped to the site completely assembled and tested.

1. If units or sections are to be disassembled at the site to allow for installation in a limited space, the unit shall be reassembled and tested for intended operation by a factory authorized technical representative.

2.3 RO WATER STORAGE TANK COORDINATION & INTEGRATION

A. Coordinate and integrate RO water treatment equipment with the RO water storage system specified in Section 232519.30, Reverse Osmosis Water Storage Tank.

1. RO water treatment equipment operation shall be controlled by the water level in the RO water storage tank with level switches and level transmitter.
2. RO equipment bypass valve shall open on abnormally low water level or by operator selection with open-closed-auto switch on RO equipment control panel.

B. Level control devices furnished by the RO equipment system manufacturer shall be coordinated with RO water tank manufacturer.

2.4 RO WATER PUMPING SYSTEM COORDINATION

A. Coordination and integrate of RO water treatment equipment with the RO water pumping system specified in Section 232519.40, Reverse Osmosis Water Pumping System.

2.5 PRESSURE GAGES

A. ASME B40.100, Grade A, 1 percent accuracy, 4-1/2 inches diameter, all metal case, bottom connected, white dials, black hands, graduated from 0 to 100 psig, with identity labeled.

2.6 WATER TESTING

A. Furnish water testing equipment in a portable cabinet made for the installed equipment.

1. Test kit to measure total water hardness, total iron, free chlorine, pH, SDI.
2. Include sufficient materials for 6 months of normal testing procedures.

B. Silt Density Index (SDI) apparatus to measure degree of suspended solids feeding the RO membranes.

1. Include pressure regulator, pressure gage, filter holder, 600 mL (20 ounce) beaker, sample valve, tubing, and 0.45 micron filter papers.

PART 3 - EXECUTION

3.1 RECEIVING AND STORAGE

A. Carefully inspect equipment and accessories upon delivery and prior to installation. Any items which are unsuitable, cracked or otherwise defective shall be rejected, removed from the job immediately, and replaced.

B. All equipment and materials shall be stored in an area that is dry and protected from the weather.

3.2 INSTALLATION

A. Install equipment and accessories in full accordance with manufacturer’s instructions.

B. Field install RO membranes in accordance with manufacturer’s instructions under on-site supervision of manufacturer’s certified field service representative.

3.3 FLUSHING AND DISINFECTION

A. Flush and disinfect new water lines, RO system, and tank interiors in accordance with AWWA C651 and equipment manufacturer’s instructions.

1. Submit and obtain approval of procedures in writing from equipment manufacturer for prior to proceeding.
2. Review procedures and manufacturer’s approval with Construction Representative and Designer prior to proceeding.

3.4 MANUFACTURER’S FIELD SERVICES

A. Provide services of a qualified manufacturer's representative to:

1. Check complete installation for conformance to manufacturer's recommendations
2. Place the system into service
3. Make all adjustments required for full conformance to design and specified requirements
4. Perform all demonstrations and tests.

3.5 START-UP AND TESTING

A. Operating: Tests shall be run in presence of Construction Representative.

B. Procedure:

1. Operate RO system at constant maximum required capacity for one hour after demineralized RO product water is produced.
   a. When necessary, waste product water to sewer to maintain above flow rate.
   b. Product water production shall begin when a sample shows that demineralization complies with requirements.
2. Demonstrate all features of the control system including process monitoring, process controls, safeties, alarms, interlocks, diagnostics, trending, etc.

C. The Construction Representative will observe startup and contractor testing of the equipment.

1. Coordinate the startup and contractor testing schedules with the Construction Representative.
2. Contractor shall provide a minimum of 10 working days notice prior to startup and testing.
3. Proper operation shall be demonstrated to the satisfaction of the Construction Representative.

3.6 DEMONSTRATION AND TRAINING

A. Provide the services of manufacturer’s technical representative for a minimum of two four hour training sessions to instruct Owner’s personnel in operation and maintenance of the system.

PIPING SPECIFICATION NO. 1

General Use: Low Pressure Water

Fabrication: Socket type, solvent weld

Pipe: PVC, Schedule 80, ASTM D1785, Type 1, Grade 1 PVC, ASTM D1784

Fittings: PVC Schedule 80, molded, socket type, solvent cement, ASTM D2467, D1784

Flanges: Class 150 PVC, ASTM D1784, Type 1, Grade 1, ANSI B16.5, flat face

Gaskets: Flat, full face, 1/8" thick EPDM

Bolting: ASTM A307, Grade B, heavy hexagon carbon steel bolts with ASTM A194, Grade 2H heavy semi-finished hexagonal nuts. Hot dipped galvanized.

Notes:
1. Materials shall be NSF-61 certified, where available.
2. All piping and components shall have a minimum pressure rating of 150 psig at 120°F.

PIPING SPECIFICATION NO. 2

General Use: High Pressure Water
Low Pressure Water (optional)

Fabrication: 1-1/2" and under: Threaded
2" and above: Welded and flanged

Pipe: 2" and under: Seamless or ERW 316L stainless steel, ASTM A312-TP316L, Schedule 40
2-1/2" and above: Seamless or ERW 316L stainless steel, ASTM A312-TP316L, Schedule 10S

Fittings: 1-1/2" and under: 150 lb. 316L stainless steel screwed fittings, ASTM A351, ANSI B16.3
2": Butt welding, 316L stainless steel, standard weight, ASTM A403-WP316L, ANSI B16.9, elbows to be long radius unless otherwise called for.
2-1/2" and above: Butt welding, 316L stainless steel, Schedule 10S, ASTM A403-WP316L, ANSI B16.9, elbows to be long radius unless otherwise called for.

Purging: Maintain inert gas purge on inside of piping during welding.

Unions and Flanges: Unions: Forged 316 stainless steel, integral seat, ASTM A182-F316, Class 3000, threaded

Flanges: ANSI Class 150, forged 316L stainless steel welding neck or slip on, ASTM A182-F316L, ANSI B16.5

Or

Flanges: ANSI Class 150, forged steel, galvanized, lap-joint (Van Stone), ASTM A105, ANSI B16.5, with stainless steel, schedule 10, Type A, stub ends, ASTM A312-TP316L, ANSI B16.9.

Gaskets: 1/8" EPDM

Bolting: ASTM A307, Grade B, heavy hexagon carbon steel bolts with ASTM A194, Grade 2H heavy semi-finished hexagonal nuts. Hot dipped galvanized.

Notes:

1. Backing or chill rings are not allowed.
2. Butt weld root pass shall be by gas tungsten arc welding (GTAW) with inert gas purge.
3. Weld procedures shall maintain corrosion resistance in weld-affected zone equal to corrosion resistance of base material.

PIPING SPECIFICATION NO. 3

General Use: Instrument Tubing (IT)

Fabrication: 1" and under: Stainless steel tube with compression fittings

Pipe: 1" and under: Stainless steel tubing, seamless, annealed, Type 316, ASTM A269, in O.D. sizes, 0.035" wall to 1/2", 0.065" wall to 1". Hardness of Rb80 or less

Fittings: 1" and under: 316 stainless steel compression type, Parker "A-lok" or approved equal.

END OF SECTION 232519.16

ATTACHMENT A -
INFLUENT SOFT WATER ANALYSIS

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ANALYTICAL RESULTS

Sample: 0065929-01
Name: Well
Matrix: Drinking Water - Grab

Sampled: 06/24/20 10:00
Received: 06/30/20 15:55
PO #: 20265

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	38	mg/L		07/01/20 09:58	25	25	07/01/20 09:58	TMS	EPA 300.0 REV 2.1
Fluoride	< 0.250	mg/L		07/01/20 09:40	1	0.250	07/01/20 09:40	TMS	EPA 300.0 REV 2.1
Nitrate-N	0.12	mg/L	H	07/01/20 09:40	1	0.03	07/01/20 09:40	TMS	EPA 300.0 REV 2.1
Sulfate	20	mg/L		07/06/20 09:09	5	5.0	07/06/20 09:09	KCC	EPA 300.0 REV 2.1
General Chemistry - PIA									
Alkalinity - bicarbonate as CaCO3	290	mg/L		07/06/20 08:22	1	10	07/06/20 08:22	TMS	SM 2320B 1997*
Alkalinity - carbonate as CaCO3	< 10	mg/L		07/06/20 08:22	1	10	07/06/20 08:22	TMS	SM 2320B 1997*
pH	7.86	pH Units	H	07/07/20 12:01	1		07/07/20 12:01	TTH	SM 4500H B 2000
Solids - total dissolved solids (TDS)	370	mg/L		07/01/20 07:25	1	17	07/01/20 08:04	bms	SM 2540C
Temperature at pH measurement	18	°C		07/07/20 12:01	1		07/07/20 12:01	TTH	SM 2550 B*
Ammonium	< 0.10	mg/L		07/16/20 14:45	1	0.10	07/16/20 14:46	JLS	calculated
Unionized Ammonia	< 0.100	mg/L		07/16/20 14:45	1	0.100	07/16/20 14:46	JLS	EPA 351.2 REV 2*
Nutrients - PIA									
Ammonia-N	< 0.10	mg/L		07/02/20 10:52	1	0.10	07/02/20 10:52	CJP	EPA 350.1 REV2
Phosphorus - total as P	< 0.10	mg/L		07/06/20 14:05	1	0.10	07/08/20 09:48	AMM	SM 4500-P F 1999*
Total Metals - PIA									
Silicon	4.0	mg/L		07/08/20 08:48	1	0.010	07/08/20 09:25	ZSA	EPA 200.7 REV 4.4
Barium	< 1.0	ug/L		07/06/20 06:45	1	1.0	07/06/20 14:06	JMW	EPA 200.8 REV 5.4
Silicon as SiO2	8.5	mg/L		07/08/20 08:48	1	0.021	07/08/20 09:25	ZSA	EPA 200.7 REV4.4
Total Hardness as CaCO3	1200	ug/L		07/06/20 06:45	1	410	07/06/20 14:06	JMW	SM 2340B 1990 18Ed
Boron	15	ug/L		07/06/20 06:45	1	10	07/06/20 14:06	JMW	EPA 200.8 REV 5.4*
Calcium	260	ug/L		07/06/20 06:45	1	100	07/06/20 14:06	JMW	EPA 200.8 REV 5.4*
Magnesium	140	ug/L		07/06/20 06:45	1	100	07/06/20 14:06	JMW	EPA 200.8 REV 5.4*
Potassium	140	ug/L		07/06/20 06:45	1	100	07/06/20 14:06	JMW	EPA 200.8 REV 5.4*
Sodium	190	mg/L		07/07/20 14:29	10	5.0	07/10/20 12:05	ZSA	EPA 200.7 REV 4.4
Strontium	< 0.0050	mg/L		07/07/20 14:29	1	0.0050	07/07/20 15:24	ZSA	EPA 200.7 REV 4.4*

NOTES

Specifications regarding method revisions and method modifications used for analysis are available upon request. Please contact your project manager.

* Not a TNI accredited analyte

Certifications

CHI - McHenry, IL - 4314-A W. Crystal Lake Road, McHenry, IL 60050
TNI Accreditation for Drinking Water and Wastewater Fields of Testing through IL EPA Accreditation No. 100279
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory Registry No. 17556

PIA - Peoria, IL - 2231 W. Altorfer Drive, Peoria, IL 61615
TNI Accreditation for Drinking Water, Wastewater, Solid and Hazardous Material Fields of Testing through IL EPA Accreditation No. 100230
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory Registry No. 17553
Drinking Water Certifications/Accreditations: Iowa (240); Kansas (E-10338); Missouri (870)
Wastewater Certifications/Accreditations: Arkansas (88-0677); Iowa (240); Kansas (E-10338)
Solid and Hazardous Material Certifications/Accreditations: Arkansas (88-0677); Iowa (240); Kansas (E-10338)

SPMO - Springfield, MO - 1805 W Sunset Street, Springfield, MO 65807
USEPA DMR-QA Program

STL - Hazelwood, MO - 944 Anglum Rd, Hazelwood, MO 63042
TNI Accreditation for Wastewater, Solid and Hazardous Material Fields of Testing through KS KDHE Certification No. E-10389
TNI Accreditation for Wastewater, Solid and Hazardous Material Fields of Testing through IL EPA Accreditation No. - 200080
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory, Registry No. 171050
Missouri Department of Natural Resources - Certificate of Approval for Microbiological Laboratory Service - No. 1050

Qualifiers

H Test performed after the expiration of the appropriate regulatory/advisory maximum allowable hold time.

Certified by: Jennifer L Solomon, Client Services Manager

PDC LABORATORIES, INC.
WWW.PDCLAB.COM

REGULATORY PROGRAM (Check one:)			
MORBCA	☐	NPDES	☐
CCDD	☐	RCRA	☐
		TACO: RES OR IND/COMM	☐

CHAIN OF CUSTODY RECORD

STATE WHERE SAMPLE COLLECTED _____

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

1 CLIENT: Walter Louis Fluid Technologies
ADDRESS: 530 S Fifth
CITY STATE ZIP: Quincy, IL 62301
CONTACT PERSON: Tina Darnell

PROJECT NUMBER:
PROJECT LOCATION: FARMINGTON CORRECTIONAL
PURCHASE ORDER #: 20265
PHONE NUMBER: 217-223-2017
E-MAIL: tina@walterlouis.com
DATE SHIPPED: 6-30-20
SAMPLER (PLEASE PRINT): ROGER SMITH
SAMPLER'S SIGNATURE: Roger Smith

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- NON AQUEOUS SOLID
LCHT-LEACHATE
OIL-OIL
SO-SOIL
SOL-SOLID

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN # 065929-1
LOGGED BY:
CLIENT:
PROJECT: Walter_Louis_DW
PROJ. MGR.: Jennifer Solomon
CUSTODY SEAL #:

2 SAMPLE DESCRIPTION (UNIQUE DESCRIPTION AS IT WILL APPEAR ON THE ANALYTICAL REPORT)	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	BOTTLE COUNT	PRES CODE (CLIENT PROVIDED)	Cl, F, NO3, SO4	Alk CO3, Alk HCO3	Ammonium	B, Ba, K, Na, Sr, SiO2	Hardness	pH, TDS	PO4	REMARKS
	6-24-20	10:00 AM	X		DW	3	2,3,6	X	X	X	X	X	X	X	

CHEMICAL PRESERVATION CODES: 1 – HCL | 2 – H2SO4 | 3 – HNO3 | 4 – NAOH | 5 – NA2S2O3 | 6 – UNPRESERVED | 7 – OTHER

5 TURNAROUND TIME REQUESTED (PLEASE CHECK) (RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE) ☒ NORMAL ☐ RUSH
DATE RESULTS NEEDED
RUSH RESULTS VIA (PLEASE CIRCLE) EMAIL ☐ PHONE ☐
EMAIL IF DIFFERENT FROM ABOVE:
PHONE # IF DIFFERENT FROM ABOVE:

6 *I understand that by initialing this box I give the lab permission to proceed with analysis, even though it may not meet all sample conformance requirements as defined in the receiving facility's Sample Acceptance Policy and the data will be qualified. Qualified data may NOT be acceptable to report to all regulatory authorities.*
PROCEED WITH ANALYSIS AND QUALIFY RESULTS: (INITIALS) _____

7

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
Tina Darnell	6-30-20	11:45 AM		6/30/20	1145
RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
	6/30/20	1555		6/30/20	1555

8 COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 2.1 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
SAMPLE ACCEPTANCE NONCONFORMANT
REPORT IS NEEDED Y OR N
DATE AND TIME TAKEN FROM SAMPLE BOTTLE _____

PAGE 3 OF 3

Qualtrax ID #3219

ATTACHMENT B -
WELL WATER QUALITY REPORT

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FARMINGTON PWS

Public Water System ID Number: MO4010270

2018 Annual Water Quality Report

(Consumer Confidence Report)

This report is intended to provide you with important information about your drinking water and the efforts made to provide safe drinking water.

Attencion!

Este informe contiene información muy importante. Tradúscalo o prequntele a alguien que lo entienda bien.
[Translated: This report contains very important information. Translate or ask someone who understands this very well.]

What is the source of my water?

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and groundwater wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Our water comes from the following source(s):

Source Name	Type
WELL # 7, 8, 9, 12, 13, 14, 16,19 & 20	GROUND WATER
WELL #15 - STONEGATE ST	GROUND WATER
WELL #17 - OVERALL ROAD	GROUND WATER
WELL #18 - MAPLE HILL DR	GROUND WATER
WELL # 5 - N JACKSON ST	GROUND WATER
WELL # 4 - STE GEN AVE	GROUND WATER

Source Water Assessment

The Department of Natural Resources conducted a source water assessment to determine the susceptibility of our water source to potential contaminants. This process involved the establishment of source water area delineations for each well or surface water intake and then a contaminant inventory was performed within those delineated areas to assess potential threats to each source. Assessment maps and summary information sheets are available on the internet at http://drinkingwater.missouri.edu/swip/swipmaps/pwssid.htm. To access the maps for your water system you will need the State-assigned identification code, which is printed at the top of this report. The Source Water Inventory Project maps and information sheets provide a foundation upon which a more comprehensive source water protection plan can be developed.

Why are there contaminants in my water?

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

Contaminants that may be present in source water include:
A. Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
B. Inorganic contaminants, such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial, or domestic wastewater discharges, oil and gas production, mining, or farming.
C. Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
D. Organic chemical contaminants, including synthetic and volatile organic chemicals, which are byproducts of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.
E. Radioactive contaminants, which can be naturally-occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, the Department of Natural Resources prescribes regulations which limit the amount of certain contaminants in water provided by public water systems. Department of Health regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Is our water system meeting other rules that govern our operations?

The Missouri Department of Natural Resources regulates our water system and requires us to test our water on a regular basis to ensure its safety. Our system has been assigned the identification number MO4010270 for the purposes of tracking our test results. Last year, we tested for a variety of contaminants. The detectable results of these tests are on the following pages of this report. Any violations of state requirements or standards will be further explained later in this report.

How might I become actively involved?

If you would like to observe the decision-making process that affect drinking water quality or if you have any further questions about your drinking water report, please call us at **573-756-0608** to inquire about scheduled meetings or contact persons.

Do I need to take any special precautions?

Some people may be more vulnerable to contaminants in drinking water than the general population. Immunocompromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

Terms and Abbreviations

Population: 19351. This is the equivalent residential population served including non-bill paying customers.
90th percentile: For Lead and Copper testing. 10% of test results are above this level and 90% are below this level.
AL: Action Level, or the concentration of a contaminant which, when exceeded, triggers treatment or other requirements which a water system must follow.
HAA5: Haloacetic Acids (mono-, di- and tri-chloracetic acid, and mono- and di-bromoacetic acid) as a group.
LRAA: Locational Running Annual Average, or the locational average of sample analytical results for samples taken during the previous four calendar quarters.
MCLG: Maximum Contaminant Level Goal, or the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
MCL: Maximum Contaminant Level, or the highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
n/a: not applicable.
nd: not detectable at testing limits.
NTU: Nephelometric Turbidity Unit, used to measure cloudiness in drinking water.
ppb: parts per billion or micrograms per liter.
ppm: parts per million or milligrams per liter.
RAA: Running Annual Average, or the average of sample analytical results for samples taken during the previous four calendar quarters.
Range of Results: Shows the lowest and highest levels found during a testing period, if only one sample was taken, then this number equals the Highest Test Result or Highest Value.
SMCL: Secondary Maximum Contaminant Level, or the secondary standards that are non-enforceable guidelines for contaminants and may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor or color) in drinking water. EPA recommends these standards but does not require water systems to comply
TT: Treatment Technique, or a required process intended to reduce the level of a contaminant in drinking water.
TTHM: Total Trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, and bromoform) as a group.

March 2, 2019

FARMINGTON PWS

Public Water System ID Number: MO4010270

2018 Annual Water Quality Report

(Consumer Confidence Report)

Contaminants Report

FARMINGTON PWS will provide a printed hard copy of the CCR upon request. To request a copy of this report to be mailed, please call us at **573-756-0608**. The CCR can also be found on the internet at www.dnr.mo.gov/ccr/MO4010270.pdf.

The state has reduced monitoring requirements for certain contaminants to less often than once per year because the concentrations of these contaminants are not expected to vary significantly from year to year. Records with a sample year more than one year old are still considered representative. No data older than 5 years need be included. If more than one sample is collected during the monitoring period, the Range of Sampled Results will show the lowest and highest tested results. The Highest Test Result, Highest LRAA, or Highest Value must be below the maximum contaminant level (MCL) or the contaminant has exceeded the level of health based standards and a violation is issued to the water system.

Regulated Contaminants

Regulated Contaminants	Collection Date	Highest Test Result	Range of Sampled Result(s) (low – high)	Unit	MCL	MCLG	Typical Source
ARSENIC	7/24/2018	1.29	0 - 1.29	ppb	10	0	Erosion of natural deposits
BARIUM	7/24/2018	0.00443	0 - 0.00443	ppm	2	2	Discharge of drilling wastes; Discharge from metal refineries; Erosion of natural deposits
NITRATE-NITRITE	7/23/2018	2.39	0.04 - 2.39	ppm	10	10	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits

Disinfection Byproducts	Sample Point	Monitoring Period	Highest LRAA	Range of Sampled Result(s) (low – high)	Unit	MCL	MCLG	Typical Source
(HAA5)	DBPDUAL-01	2018	0	0 - 0	ppb	60	0	Byproduct of drinking water disinfection
(HAA5)	DBPDUAL-03	2018	0	0 - 0	ppb	60	0	Byproduct of drinking water disinfection
TTHM	DBPDUAL-01	2018	0	0 - 0	ppb	80	0	Byproduct of drinking water disinfection
TTHM	DBPDUAL-03	2018	20	19.9 - 19.9	ppb	80	0	Byproduct of drinking water disinfection

Lead and Copper	Date	90th Percentile: 90% of your water utility levels were less than	Range of Sampled Results (low – high)	Unit	AL	Sites Over AL	Typical Source
COPPER	2016 - 2018	0.192	0.0312 - 0.368	ppm	1.3	0	Corrosion of household plumbing systems
LEAD	2016 - 2018	8.64	1.15 - 19.3	ppb	15	1	Corrosion of household plumbing systems

Radionuclides	Collection Date	Highest Value	Range of Sampled Result(s)	Unit	MCL	MCLG	Typical Source
COMBINED RADIUM (-226 & -228)	2/5/2018	2.4	0 - 2.4	pCi/l	5		Erosion of natural deposits
COMBINED URANIUM	2/5/2018	14.8	14.8	µg/l	30		Erosion of natural deposits
GROSS ALPHA PARTICLE ACTIVITY	2/5/2018	16.5	4.2 - 16.5	pCi/l			Erosion of natural deposits
RADIUM-226	2/5/2018	1.2	0 - 1.2	pCi/l	5	0	
RADIUM-228	2/5/2018	1.2	0 - 1.2	pCi/l	5	0	
URANIUM-234	7/5/2016	13.9	13.1 - 13.9	PCI/L			

Microbiological	Result	MCL	MCLG	Typical Source
COLIFORM (TCR)	In the month of June, 1 sample(s) returned as positive	TT	N/A	Naturally present in the environment

Violations and Health Effects Information

During the 2018 calendar year, we had the below noted violation(s) of drinking water regulations.

Compliance Period	Analyte	Type
No Violations Occurred in the Calendar Year of 2018		

Additional Required Health Effects Language: Certain minerals are radioactive and may emit a form of radiation known as alpha radiation. Some people who drink water containing alpha emitters in excess of the MCL over many years may have an increased risk of getting cancer.

Special Lead and Copper Notice: If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. FARMINGTON PWS is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline (800-426-4791) or at http://water.epa.gov/drink/info/lead/index.cfm.
You can also find sample results for all contaminants from both past and present compliance monitoring online at the Missouri DNR Drinking Water Watch website http://dnr.mo.gov/DWW/indexSearchDNR.jsp. To find Lead and Copper results for your system, type your water system name in the box titled Water System Name and select *Find Water Systems* at the bottom of the page. The new screen will show you the water system name and number, select and click the Water System Number. At the top of the next page, under the *Help* column find, *Other Chemical Results by Analyte*, select and click on it. Scroll down alphabetically to Lead and click the blue Analyte Code (1030). The Lead and Copper locations will be displayed under the heading *Sample Comments*. Scroll to find your location and click on the *Sample No*. for the results. If your house was selected by the water system and you assisted in taking a Lead and Copper sample from your home but cannot find your location in the list, please contact FARMINGTON PWS for your results.

March 2, 2019

FARMINGTON PWS

Public Water System ID Number: MO4010270

2018 Annual Water Quality Report

(Consumer Confidence Report)

Optional Monitoring (not required by EPA)

Optional Contaminants

Monitoring is not required for optional contaminants.

Secondary Contaminants	Collection Date	Your Water System Highest Sampled Result	Range of Sampled Result(s) (low - high)	Unit	SMCL
ALKALINITY, CACO3 STABILITY	7/23/2018	1350	223 - 1350	MG/L	
CALCIUM	7/24/2018	86.1	43.6 - 86.1	MG/L	
CHLORIDE	7/23/2018	59.4	0 - 59.4	MG/L	250
HARDNESS, CARBONATE	7/24/2018	374	223 - 374	MG/L	
IRON	7/23/2018	0.0153	0 - 0.0153	MG/L	0.3
MAGNESIUM	7/24/2018	45.5	27.7 - 45.5	MG/L	
MANGANESE	7/24/2018	0.00208	0 - 0.00208	MG/L	0.05
NICKEL	7/24/2018	0.00663	0 - 0.00663	MG/L	0.1
PH	7/24/2018	7.8	7.51 - 7.8	PH	8.5
POTASSIUM	7/23/2018	2.74	0 - 2.74	MG/L	
SODIUM	7/23/2018	39.6	3.97 - 39.6	MG/L	
SULFATE	7/24/2018	178	9.92 - 178	MG/L	250
TDS	7/24/2018	468	233 - 468	MG/L	500
ZINC	7/24/2018	0.0318	0.0011 - 0.0318	MG/L	5

Secondary standards are non-enforceable guidelines for contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor or color) in drinking water. EPA recommends these standards but does not require water systems to comply.

SECTION 232519.20 – REVERSE OSMOSIS WATER TREATEMENT SYSTEM CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install a reverse osmosis (RO) water treatment system controls as shown on the Drawings and specified herein.

B. The RO water treatment control systems shall be factory-packaged with the RO water treatment system specified in Section 232519.16 – Reverse Osmosis Water Treatment System.

C. The RO water treatment system manufacturer shall be responsible for proper coordination of the RO control system with the RO water treatment system equipment.

1.3 GENERAL

A. The control system shall include, but not be limited to, field instrumentation, wiring, controllers, operator interface systems, communication systems, data management systems, control panel, software, programming, start-up, tuning, etc.

B. Major components of the control systems are specified herein, any additional relays, switches, transducers, signal conditioners, power supplies, transformers and any other control device or equipment required to provide a complete operating control system shall be provided.

C. The control systems shall be microprocessor based.

D. Control system ranges shall be established such that normal full load operating conditions are less than full scale.

E. The control system shall be designed in accordance with UL 508A, latest edition. All applicable components shall be UL Listed and Factory Mutual approved.

F. Transmitters shall be installed in strict accordance with the manufacturer's recommendations regarding relative elevations between primary element and transmitter, piping configuration, required valves and accessories, etc.

G. For pneumatic and electric actuators, provide suitable I/P transducers, positioners, and position feedback signals.

1.4 RELATED SECTIONS

A. Section 232519.16 – Reverse Osmosis Water Treatment Equipment

B. Section 232519.30 – Reverse Osmosis Water Storage Tank

C. Section 235119.40 – Reverse Osmosis Water Pumping System

1.5 SUBMITTALS

A. Submit control panel manufacturer's UL 508A qualification and certification data.

B. Submit shop drawings to include, but not be limited to, the following:

1. Equipment list to include device identification, model, service, and calibration range.
2. Control system SAMA diagrams.
3. Layouts of operator interface display screens.
4. Trending, logging, and reporting formats.
5. Written description of control system operation.
6. Product data sheets on components.
7. Control panel layout and Bill of Materials.
8. Control panel wiring diagram.
9. Field wiring I/O connection drawings.

C. Three (3) sets of instruction manuals bound in three-ring hardbacked notebooks with tabbed, indexed page dividers and a Table of Contents shall be delivered to the Owner at least two (2) weeks prior to the start-up period and shall include, but not be limited to, the following:

1. Detailed instructions for operation and maintenance.
2. Bill of materials and manuals/data sheets for individual components.
3. Manufacturer's recommended spare parts list.
4. Drawings.

D. O&M manuals, involving drawings, shall be conformed to "as-built" status by incorporating any and all changes made during the start-up period.

E. As part of the O&M manuals, provide a back-up copy of the configuration program(s) for control system that is clearly identified and labeled.

1. Provide all required instructions and procedures for uploading and downloading the configuration program from and to the back-up storage media.

1.6 QUALITY ASSURANCE

A. The control system designer responsible for the design of the control system shall be experienced in the design of control systems for the applicable equipment and experienced in the design of control systems using controls of same manufacturer and type to be provided for this project.

1. Evidence of such experience shall be provided to the Designer upon request.

B. Start-up service engineer(s) shall be experienced in controls and safeguards startup for applicable equipment.

1. The service engineer shall have at least 5 years of experience on similar projects.

2. Upon request, provide the names and phone numbers of at least 3 references for whom the service engineer has satisfactorily performed similar work in the past 24 months.

3. Controls experience during the past year shall be on controls of the same type and manufacturer as provided on this project.

4. Service engineer(s) shall be subject to approval of Construction Representative.

PART 2 - PRODUCTS

2.1 CONTROLLERS

A. Controllers shall be industrial-process-grade, multi-loop, programmable, microprocessor programmable logic controllers (PLC). Controllers shall be one of the following:

1. Rockwell/Allen Bradley MicroLogix 1400

2. Or Engineer approved equal by Emerson-GE or Schneider Electric Modicon

B. A control panel shall be provided which contains the controllers and all associated hardware to provide a complete and operational system, including but not limited to, all processor(s), power supply(ies), chassis, input/output modules, non-volatile memory modules, communication modules, operator interface panel, lithium battery backup, terminal blocks, relays, panel wireways, circuit breakers, software, programming, etc.

1. Provide a fully operational control system meeting the requirements specified herein, in full compliance with the latest edition of the applicable codes, and fully coordinated and integrated with the applicable equipment systems.

2. Provide communications capability to allow the controller to interface with the Owner's existing Automated Logic Building Automation System (BAS) for monitoring, status reporting, and archival of data.

3. Provide 7" diagonal (minimum), programmable, NEMA 4X rated, panel mounted, color, touch screen, operator interface units (OIUs). OIUs shall be field programmable with user friendly software.

   a. Allen Bradley PanelView 800, or Designer approved equal by Emerson-GE or Schneider Electric Harmony GTO.

4. Provide battery with indicator to show when battery charge is getting low.

5. Provide one (1) copy of all software programs including site licenses.

6. The control program shall be stored in non-volatile memory, i.e., the controller program shall not be erased when the input power to the controller is turned off.

   a. If battery backed-up program chips are utilized the battery life shall be a minimum of seven (7) years.

7. Controller shall be provided with a means to download/upload a copy of the program to/from a separate storage media; USB flash drive, DVD/CD ROM, or EPROM chip.

   a. All required software and hardware including interconnecting cables, etc. shall be included.

8. Control panel will be supplied from nominal 120 VAC, 60 Hz power source.

9. Controllers shall be suitable for operation in an ambient environment of 0° to 50°C and 15% to 95% non-condensing.

10. Control system architecture shall be compliant with ISA Secure SSA 2.0.0 Level 1 standard for cyber security.

11. Control system access shall be protected by usernames and passwords with separate access privileges available for operating, tuning, downloading, system administration, etc.

12. Control system shall include configurable, real time and historical, data collection capability to support trending, logging, and reporting of all process variables.

13. Provide continuous trend displays and logging of process variables.

14. All events generated by the system (e.g. mode changes, set point changes, alarms, tuning adjustments, etc.) shall be chronologically captured, recorded, and logged to an event database using one or more permanent media. Event shall be date and time stamped.

15. Configure process control loops to provide bumpless switching between manual and automatic modes.

2.2 CONTROL PANEL

A. Provide a local control panel for the applicable equipment, which shall include, but not be limited to, the following items.

1. Control system

2. Operator interface unit

3. Surge Arrestor with LED fault indication

4. Gauges

B. All control equipment, miscellaneous devices and hardware shall be mounted in a factory wired control panel fabricated in a UL 508A certified industrial control panel shop (Category Code NITW). The completed control panel shall be UL 508A listed and labeled.

C. The control panel short circuit current rating (SCCR) shall be a minimum of 10,000 amps RMS symmetrical. Do not proceed with construction of the control panel until the required short-circuit current ratings for the control panel have been determined in accordance with Section 260573 – Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment.

D. Where there is a discrepancy between the requirements of UL 508A and what is specified herein, the requirements of UL 508A shall govern.

E. Control Panel Construction: Control panel shall be provided in a 14-gauge steel, NEMA Type 4 enclosure, 36" high x 24” wide maximum and finished with baked enamel inside (white) and outside (ANSI 49 or 61 gray).

F. Control panel enclosure shall be of sufficient depth to accommodate all controls and instrumentation.

G. Seams shall be continuously welded and ground smooth with no holes or knockouts.

H. Door shall be full height with full length continuous hinge with stainless steel hinge pin and three point latching mechanism operated by an oil-tight, key-locking handle.

I. Latch rods shall have rollers for easier door closing.

J. A data pocket shall be provided on the inside of the door.

K. Outside corners shall have a 1/4-inch radius.

L. Provide oil-resistant door gasket attached with oil-resistant adhesive and held in place with steel retaining strips or pourer-in-place gasket.

M. Provide cabinet and door grounding studs.

N. The arrangement of controls and instrumentation on the face of the control panel shall be subject to Construction Representative's approval as part of the shop drawing submittal process.

O. Fasteners required for mounting devices shall not be visible on the outside of the panel enclosure.

P. Provide white painted steel inner back panel for mounting of internal devices.

Q. All internal components shall be fastened to the back panel.

1. Internal component fasteners shall not be visible on the outside of the panel enclosure.
2. Drilling for mounting of equipment shall not be done until a check of dimensions with equipment to be installed has been made.
3. Tapped holes shall be used.
4. Self-tapping or sheet-metal screws are not allowed.

R. All cutouts shall be punched, or machine cut.

1. Cutout dimensions shall be verified.
2. Any dimensional variations resulting in changes in panel layout shall be reported to the Construction Representative for resolution before proceeding with fabrication.

S. A nameplate shall be furnished for each item on the control panel describing the function of the item.

1. Nameplates shall be white laminated plastic with black engraved characters, minimum 3/16" high.
2. Permanent nameplates or tags shall also be provided inside panels to label all devices.

T. Each control panel shall have a single-point connection for a 120 VAC, single-phase, 60 hertz power supply terminating in a circuit breaker with a minimum short circuit interrupting rating of 10,000 amps RMS symmetrical.

1. Circuit breaker shall be Allen-Bradley 1489-M series or approved equal.

U. Provide the necessary distribution circuit breakers to allow for distribution of 120 VAC power within the control panel as required.

1. Circuit breakers shall be Allen-Bradley 1489-M series or approved equal.

V. All power and control wiring shall be stranded copper, 600-volt single conductor, moisture and heat resistant, Type SIS panel wire or Type THHN-2 building wire (as required by UL 508A), rated for 90°C.

1. For 120VAC power conductors, the minimum size shall be 12 AWG.

2. For control conductors, the minimum size shall be 14 AWG.

3. All wiring and component installation shall be in accordance with the 2020 edition of the National Electrical Code (NEC).

4. All components shall have Underwriters Laboratories, Inc. approval.

W. Low-level DC analog signal cables shall be PVC insulated shielded pair; 18 AWG minimum.

X. All field and panel interconnection wiring shall be landed on terminal blocks inside the control panel.

1. Terminals for discrete I/O and power wiring shall be Allen-Bradley 1492-JKD3 or approved equal.

2. Terminals for analog I/O shall be Allen-Bradley 1492-WD3 or approved equal.

3. Terminals for power wiring shall be Allen-Bradley 1492-WKD6 or approved equal.

4. All terminal block assemblies shall include a minimum of 25% spare terminals.

5. Interconnecting wiring from external devices to the panel, as well as interconnecting wiring within the panel, shall terminate at the terminal blocks.

6. Terminal blocks shall be mounted on 1-1/2 inch Z bracket supports using T-35 DIN rail.

7. Power for each field device and each I/O module shall be individually protected by an Allen-Bradley 1489-M series, 10 kAIC rated circuit breaker located inside the panel.

8. No wire splices shall be allowed in the panel.

9. Terminal blocks shall have no more than two (2) wires connected per termination point.

10. Factory jumpers may be used where required.

a. Jumpering of live voltages using non-insulated comb type jumpers is not acceptable.

b. Isolated comb jumpers, insulated wire jumpers or jumper bars shall be used.

Y. Each wire end shall be permanently marked with a full wire number.

1. The wire markers shall be self-laminated vinyl, computer printable.

2. Thomas and Betts Series WES, with clear shrink tubing over labels.

Z. Each terminal on the terminal block shall be permanently marked with the complete terminal number and shall be installed so as to be readable from left to right and top to bottom.

1. Terminals shall be numbered with a permanent, nonconductive strip on each block according to the detailed wiring drawings to be provided by the equipment supplier.

2. Wire numbers shall not be used to identify terminals on terminal blocks.

AA. Terminal blocks shall be grouped according to function and voltage level.

BB. Terminal blocks shall be installed a minimum of six inches above the panel bottom, and flush with the wiring duct front face.

1. Utilize “high rise” DIN rail for terminal block mounting in order to meet this requirement.

CC. Not less than two inches shall be provided between terminal blocks and wiring duct or equipment for ease in wiring and wire number legibility.

DD. Terminal block groups shall be permanently identified with an engraved laminated plastic nameplate as specified on the control panel drawings.

EE. All wires going to external devices shall be terminated at terminal blocks.

1. No more than two wires shall be connected to the same terminal.

2. Each wire shall be a continuous run.

3. Splices will not be permitted.

FF. All stranded wire shall have a crimp-on pin (ferrule) installed prior to terminating on the final device or terminal block.

1. Ferrules at stranded wiring terminations within the control panel shall be crimp-on hollow pin connector:

a. Lawson P61775 (for 18 AWG conductors)

b. Lawson P61780 (for 16 AWG conductors)

c. Lawson P61785 (for 14 AWG conductors)

d. Lawson P61790 (for 12 AWG conductors)

e. Or approved equals

GG. The control panel shall be provided with a copper ground bus, bonded to the panel enclosure, having sufficient terminals for termination of all grounding conductors.

1. Instrument cable shields and DC signal common conductors shall be connected to a separate copper ground bus, electrically isolated from the control panel structure, (DC GROUND BUS) if/as recommended by the control system hardware manufacturer, control system integrator or UL 508A requirements.

2. All analog shields shall be connected to ground at one point only (usually the source end).

HH. Conductors shall be identified at each termination by marking with a number to correspond with the wiring diagrams. In addition, grounding conductors shall be identified with green insulation or green vinyl tape at termination points.

II. Plastic wiring duct shall be used to enclose panel wiring.

1. The panel wire duct material shall not support combustion.
2. It shall be made of non-warping, insulating material rated for the highest voltage applied to any conductor contained.
3. The wire duct color shall be the same throughout the panel.
4. The duct shall be securely fastened to the panel with screws and washers or rivets.
5. The wireway shall not contain exposed metal parts, except for the mounting screws.

JJ. Wiring within the control panel shall be routed within wiring duct wherever possible.

1. Wire shall be neatly arranged within and exiting from duct.
2. A small loop of wire shall be left in the wiring duct when connecting to terminal strips.
3. Wire identifications shall not extend into the wire duct.
4. The AC wiring or DC wiring shall not be mixed in the same duct.

KK. Wiring duct shall be provided from the entry point of external cable to the termination point of the cables.

1. The AC wiring and DC wiring leading from the devices and terminal blocks to the field shall be formed to exit separately in dedicated areas of the panel.

LL. Field side of terminal blocks shall be free of wiring. An empty run of wiring duct shall be provided for field wiring.

MM. Bundling of wires, except within covered wireway, shall be accomplished with Thomas and Betts “Ty-Raps” or approved equal.

1. The Contractor shall use the manufacturer’s installation tool to prevent sharp edges after the “Ty-Raps” have been cut.
2. All wiring to door or swing-open panel mounted devices shall be suitably looped, protected with spiral wrap, and secured with “Ty-Rap” mechanically installed mounted bases, Catalog No. TC5828 or approved equal.

NN. All wiring across hinges or to movable panels shall have Class C stranding.

OO. All components shall be arranged for easy access for future modification and maintenance.

1. Panels shall have a minimum of 2-inch space between outer edge of mounted components and side of panel.
2. Panels shall have a minimum of 2-1/2 inch space between all mounted components and wireway.
3. No wire splices are permitted in panels.
4. All devices in enclosures must be readily accessible.

PP. All electrical nodes and switches, indicating lights, relays, or other control devices are to be wired to terminal blocks inside the control panel.

QQ. All control panel wiring and grounding of components shall comply with IEEE-518, IEEE-142 and Allen-Bradley Publication 1770 - 4.1 "Industrial Automation Wiring and Grounding Guidelines".

RR. If required, miscellaneous piping or tubing required shall be brought to a bulkhead for connection to field piping.

1. All lines shall be identified at the bulkhead with stamped non-ferrous metal tags wired with stainless steel wire to each tube or with engraved plastic tags, each firmly cemented at each bulkhead connector.
2. Letters shall be minimum 3/16" high.
3. All tubing shall be stainless steel, except where required otherwise by code or operating requirements.
4. Piping and tubing shall have shut-off and drain valves suitable for the service at each instrument connection.

SS. The control panel shall be quality checked and tested before shipment from the factory.

1. All tags and nameplates shall be checked for correct color, size, letter size, spelling, and location.
2. Continuity and point-to-point tests of all wiring shall be performed.

2.3 PILOT LIGHTS

A. Pilot light units shall be NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted 120VAC, push-to-test, full voltage with high intensity LED type lamps.

1. Lamps shall be replaceable by removal of the color cap.
2. Color of pilot lights shall be as required by industry standards.
3. Pilot light devices shall be identified with manufacturer's collar legend plates.

B. Pilot lights shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

2.4 PUSH BUTTONS

A. Push button operator units shall be NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted with fully guarded (flush) spring loaded (momentary) type operator.

1. Color of pilot lights shall be as required by industry standards.
2. Push buttons shall be identified with manufacturer's collar legend plates.

B. Push button operator units shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

2.5 SELECTOR SWITCHES

A. Selector switch operator units shall be NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted with the “standard” type operator.

B. Selector switch operator units shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

2.6 EMERGENCY TRIP PUSH BUTTON

A. Provide emergency trip push button on front of control panel to trip equipment off-line in an emergency.

B. Push button shall be push-to-trip, twist/pull to reset, NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted with 60mm red aluminum or plastic head with “E-STOP” on cap with the number of normally open or normally closed contacts required for the application. Provide a stainless-steel guard to prevent inadvertent activation.

C. Push button operator units shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

PART 3 - EXECUTION

3.1 RECEIVING AND STORAGE

A. Carefully inspect control, instrumentation, and accessories upon delivery and prior to installation. Any items which are unsuitable, cracked or otherwise defective shall be rejected, removed from the job immediately, and replaced.

B. Store in an area that is dry and protected from the weather.

3.2 INSTALLATION

A. Install control, instrumentation, and accessories in full accordance with manufacturer’s instructions.

3.3 MANUFACTURER’S FIELD SERVICES

A. Provide services of a qualified manufacturer's representative to:

1. Check complete installation for conformance to manufacturer's instructions.
2. Configure, calibrate, adjust, and put the control system into regular, satisfactory operation.
3. Make all adjustments required for full conformance to design and specified requirements.
4. Perform all demonstrations and tests.
5. Instruct Owner's personnel in the operation and maintenance of control system.

3.4 START-UP, TESTING, DEMONSTRATION, AND TRAINING

A. Comply with the start-up, testing, demonstration, and training requirements in the applicable equipment specification section.

END OF SECTION 232519.20

SECTION 232519.30 – REVERSE OSMOSIS WATER STORAGE TANK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install a reverse osmosis water storage tank as shown on the Drawings and specified herein.

1.3 GENERAL

A. Provide complete, industrial grade, reverse osmosis water storage tank, which is factory-packaged and fully integrated with the reverse osmosis (RO) water treatment system specified in Section 232519.16, Reverse Osmosis Water Treatment Equipment.

B. Equipment size, connections, fittings, and accessories shall be coordinated with the available space, available access for installation, and the drawings.

1.4 RELATED SECTIONS

A. Section 230501 - General Mechanical Requirements for HVAC

B. Section 232519.16 – Reverse Osmosis Water Treatment Equipment

C. Section 232519.40 – Reverse Osmosis Water Pumping System

1.5 REFERENCE DOCUMENTS

A. The latest edition of the publications listed below form a part of this specification to the extent applicable. The publications are referenced in the text by their basic designation only.

B. ASTM International (ASTM):

1. D618 Practice For Conditioning Plastics For Testing
2. D648 Heat Distortion Temperature
3. D638 Tensile Properties
4. D790 Flexural Properties Of Plastic
5. D883 Definitions Of Terms Relating To Plastics
6. D1505 Density By Density Gradient Technique
7. D1693 Test Method For Environmental Stress-Cracking Of Ethylene Plastics
8. D1921 Particle Size (Sieve Analysis) Of Plastic
9. D1998 Standard Specification For Polyethylene Upright Storage Tanks
10. D2765 Degree Of Cross-Linking Ethylene Plastics As Determined By Solvent Extraction
11. D2837 Test Method For Obtaining Hydrostatic Design Basis For Thermoplastic Pipe Materials Or Pressure Design Basis For Thermoplastic Pipe Products
12. D3892 Practice For Packaging/Packing Of Plastics

13. D4703 Practice For Compression Molding Thermoplastic Materials Into Test Specimens, Plaques, Or Sheets
14. E691 Practice For Conducting An Interlaboratory Study To Determine The Precision Of A Test Method
15. F412 Terminology Relating To Plastic Piping Systems
16. ARM Std. Low Temperature Impact Resistance (Falling Dart Test)

1.6 TERMINOLOGY

A. General – definitions are in accordance with ASTM D883 and F412, unless otherwise specified.

B. Rotational molding – a four stage process consisting of loading resin in the mold; heating/fusion of the material while biaxial rotating; air-cooling, and removal.

1.7 SUBMITTALS

A. Manufacturer's literature, data, and shop drawings including, but not limited to:

1. Full item description including optional features and accessories, materials, standards compliance, model numbers, size, and capacity.
2. Equipment general arrangement to include sizes, dimensions, weights, connection points, design parameters, required maintenance clearance, painting, etc.

B. Installation manuals.

C. Operation and maintenance manuals including:

1. All aspects of system operation.
2. Maintenance procedures
3. List of recommended spare parts (manufacturer, model number, and quantity)
4. Information explaining any special knowledge or tools the owner will be required to employ.

D. Training plan and instructor qualifications.

E. Factory test results.

F. Field test results.

1.8 QUALITY ASSURANCE

A. Manufacturer shall have been engaged in the manufacture of the specified tanks as a primary product for at least ten years. The ten year requirement supersedes any conflicting requirement in other parts of the project specification.

1.9 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of tank system that fail in materials or workmanship within specified warranty period:

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications and Drawings, the Reverse Osmosis Water Tank shall be heavy duty, industrial type, manufactured by one of the following, or approved equal:

1. Assmann (Design Basis)
2. Chem-tainer
3. Miller Plastic Products
4. Norwesco
5. PolyProcessing
6. US Plastic Corporation
7. Or Engineer approved equal.

2.2 GENERAL

A. Provide a factory-packaged, factory-tested, RO water storage tank, which is designed for the project conditions and coordinated with the project drawings.

B. Equipment shall be arranged to allow easy access for operation, maintenance, and repair.

C. Tank capacity and size shall be as follows:

1. Nominal 2500 gallons to overflow.
2. 96” maximum diameter x about 91” straight side wall height.
3. About 120” maximum overall height.

D. Tank size and dimensions may be adjusted to suite existing building openings, subject to approval of Engineer.

2.3 REVERSE OSMOSIS (RO) WATER STORAGE TANK (T-01)

A. Tank shall be an above ground, atmospheric, vertical, free-standing, closed-top, flat-bottom, one-piece, seamless, rotationally molded, opague, UV-stabilized, low temperature impact resistant, virgin, FDA conforming, crosslinked high density polyethylene, storage tank, which is suitable for storage of RO permeate.

B. Tank shall comply with ASTM D-1998 standards for liquid storage and shall have ISO 9001 and NSF/ANSI 61 certifications.

C. Tank shall be rated for service from -40 F to 150 F.

D. Material Requirements:

1. Resin shall be virgin cross-linked polyethylene, Schulink XL 350 or equivalent.
2. Tanks shall contain a suitable ultraviolet stabilizer, minimum 0.3% 2-hydroxy-4-n-Octoxy-benzophenone or equivalent.
   a. The stabilizer shall be compounded into the polyethylene.
3. No fillers shall be added to resin.
4. The resin supplier’s recommended maximum material use temperature for cross linked resin shall be 150 degrees F.
5. Material properties shall be as follows:
   a. ASTM D1505 - Density (g/cc) .94

b.	ASTM 1693 - ESCR (hrs)	
	1) 10% solution	>1,000
	2) 100% solution	>1,000
c.	ASTM D790 - Flexural modulus (psi)	102,000
d.	ASTM D638 - Tensile strength (psi)	2,800
e.	ASTM D638 - Ultimate Elongation	350%
f.	Low Temperature Impact Test (ft.-lbs.) (ARM 1/8 -in. thickness, -40 C)	63
g.	UV-stabilized	Yes
h.	FDA-grade resin	Yes

E. Design Requirements:

1. The minimum required wall thickness of the cylindrical straight shell at any fluid level shall be determined by the following equation, but shall not be less than 3/16-in. thick. The tolerances indicated below apply to these dimensions.
   a. $T = \frac{P \times O.D.}{2 \times SD} = \frac{0.433 \times S.G. \times H \times O.D.}{2 \times SD}$
   b.
   c. T = Wall thickness, inches
   d. SD = Hydrostatic design stress, psi
   e. P = Pressure (.433 x S.G. x H), psi
   f. S.G. = Specific gravity of fluid
   g. O.D. = Outside diameter, inches
   h. H = Height, feet
2. Tank shall be designed for use with materials having a specific gravity from 1.0 to 2.2.
3. The hydrostatic design shall be determined by multiplying the hydrostatic design basis (determined by ASTM D2837 using rotationally molded samples) by a service (design) factor selected for the application.
4. The tank shall be designed and molded with a uniform wall thickness equal to or greater than the minimum thickness requirement per the Barlow Formula shown in this specification.
5. Tank shall be air-cooled in chambers with high velocity fans giving a controlled temperature drop, insuring a more uniform resin cure, reduced residual stress, improved shrinkage parameter, and a more consistent product.
6. Top head shall be integrally molded (one piece) with the cylinder shell.
7. The minimum thickness of the top head shall be 3/16-in. The tolerances indicated below apply to this dimension.
8. Tanks top shall include mounting flats to enhance fixture assemblies.
9. The bottom head of a tank shall be integrally molded (one piece) with the cylinder shell. The minimum thickness for a fully supported flat bottom head shall be 3/16-in.
10. All parting lines shall be located within the top 1/3 of the vertical sidewall.

F. Tank Stand:

1. Provide tank manufacturer's standard tank stand, which elevates tank 12" above grade to allow for full tank drainage and flooded pump suction. Tank stand shall include, but not be limited to, the following:

   a. Chemical resistant polyethylene construction with corrugated sidewalls for maximum support and crush resistance to 300,000 pounds.

b. Lightweight modular sections with dovetail interlocking joints and perimeter strap.
c. Seismic and wind load anchoring points.
d. Color selection by Construction Representative.

G. Nozzles:

1. Tank nozzles shall be provided as indicated on the drawings and specified below.
2. Pump suction nozzle shall be a 4" diameter, molded in full drain outlet with 316 stainless steel insert, which provides for full tank drainage, with polyethylene flange adapter, butterfly valve, and flanged flexible expansion joint.
3. RO inlet nozzle shall be provided with Schedule 80 PVC drop tube assembly with anti-siphon hole and polyethylene support bracket with EDPM gasket and EPDM encapsulated 316 stainless steel bolts. Drop tube to extend to within 6" of floor.
4. Nozzles 3" or less: Bulkhead fittings, Schedule 80 PVC, male NPT nipples, flange adapter, EPDM gaskets.
5. Nozzles 4" or larger: Rolled flange fittings, ¼" rolled plates conforming to tank inside and outside diameter, minimum schedule 10S pipe stub, minimum ¼" flange with ANSI Class 150 flange pattern, 316 stainless steel construction, EPDM gaskets, 316 stainless steel bolting hardware.
6. Mushroom Vent Assembly: 6" diameter, polyethylene construction with 316 stainless steel bolting hardware, EPDM gaskets, and polyethylene screen.
7. Top Access Manway: 24" diameter opening with hinged polyethylene cover assembly and hold-down straps.

H. Expansion Joints:

1. Provide tank manufacturer's standard or recommended EPDM expansion joints with galvanized or stainless steel back-up flanges with all tank connections.

I. Valves:

1. Provide tank manufacturer's standard or recommended PVC butterfly or ball valves with tank connections as indicated on the drawings.

J. Ladder:

1. Tank ladder and platform assembly shall be provided as indicated on the drawings.
2. Ladder and platform assemblies shall be built to the most recent OSHA guidelines from a material that is chemically resistant to the environment.
3. Suitable materials shall be isophthalic polyester or vinylester fiberglass reinforced plastic, or carbon steel with two-part epoxy primer and black epoxy finish.
4. The ladder shall have a 24" x 24" platform with a 48" high handrails.
5. The top of the platform shall be located 48" below the top manway promontory.
6. The ladder shall be fastened to the vessel with minimum ½" diameter Viton or EPDM gasketed bolts at the platform and shall be anchored to the concrete at the base of the ladder.

K. Seismic Restraint System:

1. Wind and Seismic Restraint Systems shall be designed to meet current requirements of the International Building Code.
2. Design calculations shall be provided with the technical drawings.

3. Restraints shall be cable type attached to tank stand or foot pads anchored to the concrete foundation.
4. The cable assemblies shall extend from an anchor up and over the centerline of the vessel's top head and down 180 degrees from the point of origin.
5. A turnbuckle shall be supplied on at least one side of each cable assembly to adjust cable tension. The cable assemblies shall be tethered together at the intersection.
6. Restraint hardware shall include, but not be limited to, the following:
    a. Galvanized or stainless steel aircraft cables, swage fittings, thimbles, turnbuckle, cable clamps, eyebolts, bolting hardware.
    b. Rotationally molded polyethylene restraint clips, cable guides, and tie down lugs with stainless steel through-hole insert pipes.

L. Lifting Lugs: Manufacturer's standard lifting lugs.

M. Nameplate: Indicating Manufacturer, model, capacity, material, design pressure, date of manufacture, contents.

N. Dimensions and Tolerances:

1. General - dimensions shall be taken with tank empty.
2. Thickness – The tolerance for thickness shall be +/- 3%
3. Fitting placement – The tolerances for fitting placement shall be +/- 3% in elevation and degree.

O. Workmanship:

1. The finished tank wall, so far as is commercially practical, shall be free of visual defects such as foreign inclusions, air-bubbles, and pinholes that may impair the serviceability of the vessel.
2. The inner surface shall be smooth and free of cracks, crazing or pits.
3. Waviness is considered a characteristic of the molding process for large tanks and is acceptable, provided the surface is smooth and free of cracks.

P. Quality Assurance:

1. Materials (Resins):
    a. Manufacturer shall verify
        1) Receipt of a supplier certification that each lot of resin conforms to supplier's specification.
        2) That each lot of resin complies with its purchase order.
    b. Manufacturer will visually examine each lot of resin for contamination, color, texture, etc.
    c. Samples of each lot must be stored a minimum 3 years.
    d. Each crosslinked lot sample shall be processed and tested for gel consistency.
2. Vessels
    a. Factory testing shall include, but not be limited to:
    b. Impact test
    c. Gel test
    d. Hydrostatic test
    e. Ultrasonic thickness test

Q. Marking:

1. Each tank shall be marked with a quality and routing control number, which shall be used to trace the vessel and shall be common to all required documentation.
2. Product identification label with installation and use instructions will be applied to each tank.

2.4 RO SYSTEM COORDINATION

A. Coordinate tank level element fittings with level elements furnished with Reverse Osmosis Water Treatment Equipment specified in Section 232519.16.

PART 3 - EXECUTION

3.1 RECEIVING AND STORAGE

A. Carefully inspect equipment and accessories upon delivery and prior to installation.

B. Any items which are unsuitable, cracked or otherwise defective shall be rejected, removed from the job immediately, and replaced.

C. All equipment and materials shall be stored in an area that is dry and protected from the weather.

3.2 INSTALLATION

A. Install equipment and accessories in full accordance with manufacturer's instructions.

B. Unload, stored, handle, and install equipment and accessories in such a manner as not to degrade quality, serviceability, or appearance.

C. Store vertical tanks in an upright position with full bottom support on a clean, flat surface with no sharp objects under the tank.

D. Install concrete tank foundation with a smooth, level, and planar surface to provide full bottom support of tank.

E. Clean concrete surface of all debris.

F. Install a bond breaker between tank and concrete surface.

1. Bond breaker shall be minimum of 6 layers of 15 lb roofing felt, or other suitable material as specified by tank manufacturer.

G. Position the tank before assembling to peripheral equipment to ensure proper clearances.

H. Provide anchor bolts (galvanized or stainless steel) as required for anchoring tank, seismic restraints, and access ladders.

I. Support piping independently of the tank.

J. Install flexible expansion joints between tank and pipe supports to allow the tank to expand and contract when filling and draining.

3.3 HYDROSTATIC TESTING

1. Fill tank to overflow line with clean, potable water after all pipe connections and accessories are installed and check for leaks.
2. Completely drain and dry tank after hydrotest.
3. Inspect tank for any signs of stress cracking.

3.4 FLUSHING AND DISINFECTION

A. Flush and disinfect new water lines, RO system, and tank interior in accordance with AWWA C651 and equipment manufacturer's instructions.

1. Submit and obtain approval of procedures in writing from equipment manufacturer for prior to proceeding.
2. Review procedures and manufacturer's approval with Construction Representative and Engineer prior to proceeding.

3.5 MANUFACTURER'S FIELD SERVICES

A. Provide services of a qualified manufacturer's representative to:

1. Check complete installation for conformance to manufacturer's recommendations.
2. Inspect tank for any signs of damage.
3. Place the tank into service
4. Make all adjustments required for full conformance to design and specified requirements
5. Perform all demonstrations and tests.

3.6 START-UP AND TESTING

A. Operating: Tests shall be run in presence of Construction Representative.

3.7 DEMONSTRATION AND TRAINING

A. Provide the services of manufacturer's technical representative for a minimum of two two hour training sessions to instruct Owner's personnel in operation and maintenance of the equipment.

3.8 FINAL INSPECTION AND ADJUSTING

A. After each installation is completed, tested for leaks, cleaned and approved by the Construction Representative, it shall be filled with the fluid it is to carry.

B. The Contractor shall then test each system in actual operation, operate all valves, safety devices and equipment which he has installed and make final adjustments to place the system in operation.

C. Such operation shall be demonstrated to the satisfaction of the Construction Representative.

END OF SECTION 232519.30

SECTION 232519.40 – REVERSE OSMOSIS WATER PUMPING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install a reverse osmosis water pumping system as shown on the Drawings and specified herein.

1.3 GENERAL

A. Provide complete, industrial grade, factory-packaged, fully integrated and automated, reverse osmosis (RO) water pumping system to supply RO water to the plant's deaerator.

B. Coordinate and integrate RO pumping system with the RO water treatment system and RO water storage tank.

C. Equipment size, connections, fittings, and accessories shall be coordinated with the available space, available access for installation, and the drawings.

D. Piping shall be fabricated and installed in accordance with the Code for Pressure Piping, ANSI B31.1 (Latest) "Power Piping".

1.4 RELATED SECTIONS

A. Section 230501 - General Mechanical Requirements for HVAC

B. Section 230513 - Common Motor Requirements for HVAC Equipment

C. Section 230515 – Variable-Frequency Motor Controllers

D. Section 232519.16 – Reverse Osmosis Water Treatment Equipment

E. Section 232519.20 – Reverse Osmosis Water Treatment Equipment System Controls

F. Section 232519.30 – Reverse Osmosis Water Storage Tank

1.5 REFERENCE STANDARDS

A. The latest edition of the publications listed below form a part of this specification to the extent applicable. The publications are referenced in the text by their basic designation only.

1. Hydraulic Institute
2. ANSI – American National Standards Institute
3. ASME – American Society of Mechanical Engineers
4. ASTM – American Society for Testing and Materials
5. IEEE – Institute of Electrical and Electronics Engineers
6. NEMA – National Electrical Manufacturers Association

7. NEC – National Electrical Code
8. ISO – International Standards Organization
9. UL – Underwriters Laboratories, Inc.

1.6 SUBMITTALS

A. Manufacturer's literature, data, and shop drawings including, but not limited to:

1. Full item description including optional features and accessories, materials, standards compliance, model numbers, size, and capacity.
2. Equipment general arrangement to include sizes, dimensions, weights, connection points, design parameters, required maintenance clearance, skid painting, etc.
3. Catalog data, data sheets, and pump curves.
4. Catalog data, nameplate data and outline drawing for transfer pump motors.
5. Product data sheets for motor disconnect safety switches.
6. Piping and instrumentation diagram (P&ID). Include indication of devices tubed/wired to local control panels.
7. Material list and catalog data for instrumentation, valves, controls, trim items, accessories etc. Coordinated with P&ID.
8. Piping specifications.
9. Wiring diagrams.
10. Control panel layouts.
11. Sequence of operations.
12. Performance data including normal and maximum flow and pressure drop.

B. Installation manuals.

C. Operation and maintenance manuals including:

1. All aspects of system operation.
2. Maintenance procedures
3. Piping drawings
4. Wiring diagrams of all circuits
5. Written description of system design
6. Control logic
7. Sequence of operation
8. Troubleshooting techniques
9. Procedures for emergency situations.
10. List of recommended spare parts (manufacturer, model number, and quantity)
11. Information explaining any special knowledge or tools the Owner will be required to employ.

D. Training plan and instructor qualifications.

E. Factory test results.

F. Field test results.

1.7 QUALITY ASSURANCE

A. Manufacturer shall have been engaged in the manufacture of similar packaged pumping systems as a primary product for at least ten years. The ten year requirement supersedes any conflicting requirement in other parts of the project specification.

B. The complete packaged water pumping system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.

C. The complete packaged pumping system shall be NSF61 / NSF372 Listed for drinking water and low lead requirements.

1.8 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of pumping system that fail in materials or workmanship within specified warranty period:

1. Warranty Period: 24 months from date of Substantial Completion, not to exceed 30 months from date of manufacture.

1.9 DESIGN BASIS

A. Provide skid-mounted, variable speed, motor driven, duplex, pumping system to supply RO water at constant discharge pressure from the RO water storage tank to the steam plant's deaerator make-up water level control valve, as indicated on the Drawings.

B. System shall include, but not be limited to, two transfer pumps with variable frequency motor controllers, piping, instrumentation, wiring and controls for a fully operational system.

C. Transfer pumps shall be of corrosion resistant with materials, construction, and pressure and temperature ratings suitable for the service conditions.

1. Vertical, single or multistage, high efficiency, centrifugal type.
2. Type 316L stainless steel casing, shaft, impellers, trim.
3. Tungsten carbide and ceramic shaft seals.
4. 316L stainless steel frame with flanged piping connections.
5. Pump No. 01-A Design Point: 75 gpm at 138 feet fluid (60 psi) total dynamic head.
6. Pump No. 01-B Design Point: 75 gpm at 138 feet fluid (60 psi) total dynamic head.
7. Water Temperature: 60 F (ranges from 40 F to 80 F).
8. Pump NPSH Available: +/- 30 feet fluid at skid suction piping connection with RO water tank level 12" above centerline of pump.
9. Pump NPSH Required shall be less than 10' fluid, unless approve otherwise by Designer.
10. Premium efficiency TEFC motor, complying with Section 230513 - Common Motor Requirements for HVAC Equipment.
    a. Selected to be non-overloading on the entire performance curve.
    b. 230/460 VAC, 3 phase, 60 Hz.
    c. Maximum 5 hp.

D. Approximate Skid Size: 48" Long x 42" Wide x 70" High

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications and Drawings, the Reverse Osmosis Water Pump System shall be heavy duty, industrial type, manufactured by one of the following, or approved equal:

1. Bell & Gossett
2. Goulds Water Technology
3. Grundfos
4. Or Engineer approve equal.

2.2 REVERSE OSMOSIS (RO) WATER PUMPING SYSTEM

A. Provide skid-mounted, variable speed, motor driven, duplex, transfer pumping system to supply RO water at constant pressure from the RO water storage tank to the steam plant's deaerator make-up water level control valve, as indicated on the Drawings.

B. Equipment shall be arranged on the frame to allow easy access for operation, maintenance, and repair.

C. The entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer.

D. The packaged pump system shall be ASHRAE 90.1 (latest edition) compliant.

2.3 PUMPS

A. The pumps shall be of the in-line, vertical, multi-stage design.

B. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

C. Vertical In-Line Multi-Stage Pumps shall have the following features:

1. The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.
2. The suction/discharge base shall have ANSI Class 150 flange or internal pipe thread (NPT) connections as determined by the pump station manufacturer.
3. Pump Construction: All wetted parts shall be stainless steel suitable for use in RO water systems.
    a. Suction/discharge base, pump head: Cast 316 stainless steel (CF8M)
    b. Impellers, diffuser chambers, outer sleeve: 316 Stainless Steel
    c. Shaft: 316 Stainless Steel
    d. Impeller wear rings: 316 Stainless Steel
    e. Motor stool: Cast iron (Class 30)
    f. Shaft journals and chamber bearings: Silicon Carbide
    g. O-rings: EPDM
4. Shaft couplings for motor flange sizes 184TC and smaller shall be made of cast iron or sintered steel.
5. Shaft couplings for motor flange sizes larger than 184TC shall be made of

6. ductile iron (ASTM 60-40-18).
7. The shaft seal shall be a balanced o-ring cartridge type with the following features:
    a. Collar, Drivers, Spring: 316 Stainless Steel
    b. Shaft Sleeve, Gland Plate: 316 Stainless Steel
    c. Stationary Ring: Graphite embedded Silicon Carbide
    d. Rotating Ring: Graphite embedded Silicon Carbide
    e. O-rings: EPDM
8. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft coupling and motor.
    a. The entire cartridge shaft seal shall be removable as a one-piece component.
9. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal. (Motors will be 5hp so I don't think we need to include this reqirement.)

2.4 MOTORS

A. Comply with Section 230513 - Common Motor Requirements for HVAC Equipment.

2.5 VARIABLE FREQUENCY MOTOR CONTROLLERS

A. Comply with Section 230515 – Variable-Frequency Motor Controllers

2.6 PUMP SYSTEM CONTROLLER

A. The pump system controller shall be a standard product developed and supported by the pump manufacturer.

B. The controller shall be microprocessor based capable of having software changes and updates via personal computer (notebook).

C. The controller user interface shall have a color display with a minimum screen size of 3-1/2" x 4-5/8" for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment.

D. Password protection of system settings shall be standard.

E. Galvanic Isolation: The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

F. Backup Battery: The controller shall have the ability to be connected to a backup battery to supply power to the controller during periods of loss of supply power.

G. Home Status Screen: The controller shall display the following as status readings from a single display on the controller (this display shall be the default):

1. Current value of the control parameter (pump discharge pressure)
2. Most recent existing alarm (if any)
3. System status with current operating mode
4. Status of each pump with current operating mode and rotational speed as a percentage (%)
5. Estimated flow-rate (or actual flow if flow sensor is used)

6. One user defined measured parameter (i.e. power consumption)

H. Inputs/Outputs: The controller shall have as a minimum the following hardware inputs and outputs:

1. Three analog inputs (4-20mA or 0-10VDC)
2. Three digital inputs
3. Two digital outputs
4. Ethernet connection (built-in web server)
5. Field Service connection to PC for advanced programming, software and/or firmware upgrades and data logging.

I. Pump system programming: As a minimum, the following parameters shall be available and/or field adjustable:

1. Sensor Settings: Suction, Discharge, Differential Pressure [analog supply/range]
2. PI Controller: Proportional gain (Kp) and Integral time (Ti)
3. Low suction: Pressure/level shutdown via digital contact
4. Limit Exceeding function: For low system, low suction warnings and shut down [via analog input]
5. Flow meter settings (if used, analog signal)

J. Pump Curve Data: The actual pump performance curves (5th order polynomial) shall be loaded (software) into the pump system controller. Pump curve data shall be used for the following:

1. Display and data logging of calculated flow rate
2. Variable pressure control (quadratic or proportional)
3. Pump outside of duty range protection
4. Sequence pumps based on efficiency

K. Variable Pressure Control: In lieu of a remote mount discharge pressure sensor, the controller shall have variable pressure control to compensate for pipe friction loss by decreasing the pressure set-point at lower flow-rates and increasing the pressure set-point at higher flow-rates by using the actual flow rate or calculated flow rate.

1. Variable pressure control that uses power consumption and speed only shall not be considered equal to variable pressure control that uses actual differential pressure measurement along with pump power and speed.

L. Check Valve Failure Detection (Systems with integrated VFD motors): The system controller shall be able to detect motors turning in the opposite direction and give check valve failure notification.

1. For minor leaks the pump shall start with a warning indicated
2. For major leaks the pump shall remain off to prevent damage with an alarm indication

M. Pulse flow meter: The system controller shall be able to receive pulse readings from a digital pulse meter and log/display accumulated flow.

N. Programmable Setpoints: The system controller shall be able to accept up to seven programmable set-points via a digital input, (additional input/output module shall provided, if required).

O. Setpoint Influence: The system pressure set-point shall be capable of being automatically adjusted by using an external set-point influence. The set-point influence function enables the user to adjust the control parameter (pump discharge pressure) by measuring an additional parameter.

P. Local Control: Provide hand-off-auto selector switch for each pump mounted in the skid mounted control panel.

Q. Remote Control: The controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

R. Setpoint Ramp: The controller shall be able to adjust the ramp time of a change in set point (increase and decrease).

S. Warnings and Alarms: The pump system controller shall store up to 24 warnings and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:

1. Individual pump failure
2. Check valve failure
3. VFD trip/failure
4. Loss of sensor signal (4-20 mA)
5. Loss of remote set-point signal (4-20mA)
6. External Fault
7. Pump outside of duty range
8. Dry run protection via suction pressure transducer
9. High discharge pressure via discharge transducer.

T. Built-in data log: The controller shall have built-in data logging capability. Logged values shall be graphically displayed on the controller and shall be downloadable to a notebook/pc as a delimited text file. A minimum of 7200 samples per logged value shall be available for the following parameters:

1. Estimated flow-rate (or actual flow if flow sensor is connected)
2. Speed of pumps
3. Process Value/sensor feedback (discharge pressure)
4. Power consumption
5. Controlling parameter (setpoint)
6. Inlet pressure

U. Redundant Primary Sensor: The controller shall be capable of receiving a redundant sensor input to function as a backup to the primary sensor.

V. Secondary Sensor: Upon loss of signal from the remote sensor, the controller shall be capable of reverting control to the pump system mounted sensors with a programmable setpoint. The pumps shall maintain a constant, proportional or quadratic pressure across the system until the remote setpoint signal is restored.

W. Pump Test: The controller shall have a pump "Test Run" feature such that pumps are switched on during periods of inactivity (system is switched to the "off" position but with electricity supply still connected). The inoperative pumps shall be switched on for a period of three to four seconds every 24 hours, 48 hours or once per week and at a programmable time of day.

X. Reduced Operation: During backup generator operation, the controller shall be capable of reducing the power consumed by the pump system by either limiting the number of pumps in operation or by limiting the amount of power consumption (kW). The controller shall receive a digital input indicating backup generator operation.

Y. Power and Energy Consumption: The controller shall be capable of displaying instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours).

Z. Specific Energy: When a flow sensor is connected, the controller shall be capable of displaying instantaneous specific energy in Watt-hours per gallon (Wh/gal) or Watt-hours per 1,000 gallons (Wh/kgal).

AA. Built-in Ethernet: The controller shall have an Ethernet connection with a built-in web server allowing for connection to a building computer network with read/write access to the controller via a web browser.

BB. Service Contact Information: The controller shall have a programmable Service Contact Field that can be populated with service contact information including: contact name, address, phone number(s) and website.

2.7 COMMUNICATION INTERFACE

A. Provide a communications interface between the new RO pump control system and the existing power plant building automation system (Automated Logic).

1. Provide pump system displays with all available system data, alarms, event history, etc. on the existing power plant operator interface station.
2. Duplicate the pump system operator interface screens on the power plant's operator interface station to the extent possible.
3. Provide critical system data collection, trending, and archiving to the power plant work station.
4. Remote pump system control from the power plant operator interface station is not required, but shall be a capability for future consideration.
5. Communication interface shall be BACnet (which is preferred) or Modbus with hardwire MSTP or TCP/IP protocol. Field verify.

B. The existing power plant control system was installed and has been serviced by Premium Mechanical & Automation (573-243-3918, Randy Henley, Don Henley).

2.8 CONTROL PANEL

A. All control equipment, miscellaneous devices and hardware shall be mounted in a factory wired control panel fabricated in a UL 508A certified industrial control panel shop (Category Code NITW). The completed control panel shall be UL 508A listed and labeled.

B. The control panel short circuit current rating (SCCR) shall be a minimum of 10,000 amps RMS symmetrical. Do not proceed with construction of the control panel until the required short-circuit current ratings for the control panel have been determined in accordance with Section 260573 – Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment.

C. Where there is a discrepancy between the requirements of UL 508A and what is specified herein, the requirements of UL 508A shall govern.

D. Control panel shall comply with all applicable requirements of Paragraph 2.2 Control Panel in Section 232519.20 – Reverse Osmosis Water Treatment System Controls.

E. BAS Integration: Standard shall be BACnet MS/TP
   1. *Other protocols available: BACnet IP, Ethernet IP, Modbus RTU, Modbus TCP, LON

F. The pump system controller shall be mounted in a UL/NEMA Type 4 rated enclosure. A self-certified NEMA enclosure rating shall not be considered equal. The entire UL Type 4 control panel shall be UL 508A listed and labeled. The control panel shall include a main disconnect and circuit breaker(s) for the 120VAC incoming power circuit and control relays for alarm functions. The control panel shall include the following:

   1. System Fault Audible Alarm with push button to silence
   2. Emergency/Normal Operation Switches (Control bypass)
   3. Individual Service Disconnect Switch for each pump motor mounted to the skid. These shall not be included as part of the skid mounted control panel but shall be in separate NEMA Type 4 enclosures.
   4. Pump Run Lights
   5. System Fault Light
   6. Hand-Off-Automatic Selector Switch for each pump
   7. Surge Arrestor with LED fault indication

2.9 PILOT LIGHTS

A. Pilot light units shall be NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted 120VAC, push-to-test, full voltage with high intensity LED type lamps.

   1. Lamps shall be replaceable by removal of the color cap.

   2. Color of pilot lights shall be as required by industry standards.

   3. Pilot light devices shall be identified with manufacturer's collar legend plates.

   4. Pilot lights shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

2.10 PUSH BUTTONS

A. Push button operator units shall be NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted with fully guarded (flush) spring loaded (momentary) type operator.

   1. Color of pilot lights shall be as required by industry standards.

   2. Push buttons shall be identified with manufacturer's collar legend plates.

3. Push button operator units shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

2.11 SELECTOR SWITCHES

A. Selector switch operator units shall be NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted with the "standard" type operator.

B. Selector switch operator units shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

2.12 EMERGENCY TRIP PUSH BUTTON

A. Provide emergency trip push button on front of control panel to trip equipment off-line in an emergency.

B. Push button shall be push-to-trip, twist/pull to reset, NEMA Type 4/4X/13 watertight/corrosion-resistant/oiltight, fiberglass reinforced thermoplastic polyester, 30 or 30.5mm round, panel mounted with 60mm red aluminum or plastic head with "E-STOP" on cap with the number of normally open or normally closed contacts required for the application. Provide a stainless-steel guard to prevent inadvertent activation.

C. Push button operator units shall be Allen-Bradley Bulletin 800H, Eaton Cat. No. E34 or equal by Square D Company, Class 9001, or ABB-GE.

2.13 ALARM HORN

A. Alarm horn shall be 120 VAC, 60 Hz, 100 dB minimum at 10 feet, Federal Signal Model 350 with NEMA 4 gasket, or approved equal by Ametek Panalarm or Edwards, for annunciation of alarm conditions. Horn shall be semi-flush mounted in the face of control panel. Provide an "alarm silence" push button.

2.14 SEQUENCE OF OPERATION

A. The system controller shall operate equal capacity variable speed pumps to maintain a constant discharge pressure setpoint from a local mounted pressure sensor.

B. The system controller shall receive analog signals [4-20mA] from the factory installed pressure transducers on the discharge and suction manifolds, indicating the actual system pressure and inlet pressure.

C. Standard Cascade Control (Pumping Efficiency Based):
   1. The pump system controller shall adjust pump speed as necessary to maintain system set-point pressure as flow demand increases.
      a. Utilizing the pump curve information (5th order polynomial), the pump system controller shall stage on additional pumps when pump hydraulic efficiency will be higher with additional pumps in operation.
      b. Exception: When the flow and head are outside the operating pump(s) allowable operating range, the controller shall switch on an additional pump thus distributing flow and allowing all pump(s) to operate in allowable operating range.

c. When the system pressure is equal to the system set-point, all pumps in operation shall reach equal operating speeds.
d. The pump system controller shall have field adjustable Proportional Gain and Integral time (PI) settings for system optimization.

2. Optional Cascade Control (Pump Start Speed Based):
a. As flow demand increases the pump speed shall be increased to maintain the system set-point pressure.
b. When the operating pump(s) reach 96% of full speed (adjustable), an additional pump will be started and will increase speed until the system set-point is achieved.
c. When the system pressure is equal to the system set-point all pumps in operation shall reach equal operating speeds.
d. The pump system controller shall have field adjustable Proportional Gain and Integral time (PI) settings for system optimization.

D. The system controller shall be capable of switching pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.

E. All pumps in the system shall alternate automatically based on demand, time and fault.

1. If flow demand is continuous (no flow shut-down does not occur), the system controller shall have the capability to alternate the pumps every 24 hours, every 48 hours or once per week.
2. The interval and actual time of the pump change-over shall be field adjustable.

2.15 SYSTEM CONSTRUCTION

A. Suction and discharge manifold construction shall be in way that ensures minimal pressure drops, minimize potential for corrosion, and prevents bacteria growth at intersection of piping into the manifold.

B. Manifold construction that includes sharp edge transitions or interconnecting piping protruding into manifold is not acceptable. Manifold construction shall be such that water stagnation cannot exist in manifold during operation to prevent bacteria growth inside manifold.

C. The suction and discharge manifolds material shall be 316L stainless steel. Manifold pipe schedule and connection sizes shall be as follows:

1. 3 inch and smaller: Schedule 40S, Male NPT threaded
2. 4 inch through 8 inch: Schedule 10S, ANSI Class 150 rotating flanges
3. 10 inch and larger: ANSI Class 150 flanges

D. Pump Isolation valves shall be provided on the suction and discharge of each pump.

1. Isolation valve sizes 2 inch and smaller shall be 316 stainless steel full port ball valves.
2. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of 316 stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy.

E. A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the check valve shall not exceed 5 psi at the pump design capacity.

1. Check valves 1-1/2" and smaller shall have a POM composite body and poppet, a 316 stainless steel spring with EPDM seats.
2. Check valves 2" and larger shall have a body material of 316 stainless steel with an EPDM resilient seat. Spring material shall be 316 stainless steel. Disk shall be of 316 stainless steel.

F. A recirculation line with orifice, check valve, and isolation valves shall be installed on the discharge of each pump for recirculation of water to the RO storage tank.

1. Orifice shall be sized for minimum pump continuous flow with the pump operating at full rated speed.

G. A pressure transducer shall be factory installed on the discharge manifold for discharge pressure control and on the suction manifold for dry run protection.

H. Systems with positive inlet gauge pressure shall have a factory installed pressure transducer on the suction manifold for water shortage protection.

I. Systems with a flooded suction inlet or suction lift configuration shall have a factory installed water shortage protection device on the suction manifold.

J. Pressure transducers shall be made of 316 stainless steel.

1. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale.
2. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

K. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds.

1. The gauge shall be liquid filled and have stainless steel alloy internal parts in a stainless steel case.
2. Gauge accuracy shall be 2/1/2 %.
3. The gauge shall be capable of a pressure of 30% above its maximum span without requiring recalibration.

L. Skid and Frame Assembly: Equipment shall be built on a skid and frame constructed of corrosion resistant 304 stainless steel or welded structural carbon steel with factory applied corrosion resistant coating.

M. Rubber vibration dampeners shall be fitted between each pumps and base frame to minimize vibration.

N. Depending on the system size and configuration, the control panel shall be mounted in one of the following ways:

1. On a 304 stainless steel fabricated control cabinet stand attached to the system skid.
2. On a 304 stainless steel fabricated skid, separate from the main system skid.
3. On its own base (floor mounted with plinth)

2.16 FACTORY TESTING

A. The tester used for testing the pump system shall be constructed and calibrated according to the requirements of hydraulic test standard ISO 9906.

B. The entire pump station shall as a minimum be factory tested for functionality and documented results of functionality test supplied with pump station.

C. Functionality testing shall include the following parameters:

1. Complete System Hydrostatic Test – 1.5 times the nameplate maximum pressure
2. No-Flow Detection Shutoff Test
3. Water Shortage Test
4. Two-Point Setpoint Performance Test.

D. Water used for testing shall be treated with three different filtration systems to ensure only clean water is used for testing pump station.

1. 25 micron mechanical filter – removes solid parts from water
2. Activated carbon filter – keeps water clear and eliminates odor
3. Ultraviolet light system – kills all bacteria growth

E. Optional performance testing shall include:

1. 10-Point Verified Performance Test

PART 3 - EXECUTION

3.1 RECEIVING AND STORAGE

A. Carefully inspect equipment and accessories upon delivery and prior to installation. Any items which are unsuitable, cracked or otherwise defective shall be rejected, removed from the job immediately, and replaced.

B. All equipment and materials shall be stored in an area that is dry and protected from the weather.

3.2 INSTALLATION

A. Install equipment and accessories in full accordance with manufacturer’s instructions.

B. Complete piping installation as required for operation of system and as indicated on the Drawings.

C. All piping shall be brought to pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections from the piping.

D. All piping shall be properly aligned and fitted to the pumps without pulling or pulling.

3.3 MANUFACTURER’S FIELD SERVICES

A. Provide services of a qualified manufacturer's representative to:

1. Check complete installation for conformance to manufacturer's recommendations.

2. Configure system controls and instrumentation.
3. Place the system into service.
4. Make all adjustments required for full conformance to design and specified requirements.
5. Perform all start-up, demonstrations, and tests.

3.4 START-UP AND TESTING

A. Operating: Tests shall be run in presence of Construction Representative.

B. Check out unit in accordance with Installation, Operation & Maintenance manual, prior to energizing.

C. When the system and pump are filled with the fluid to be pumped, and before placing in continuous operation, make preliminary checks as follows.

1. Pump and motor alignment.
2. Lubrication of all components including bearings and coupling.
3. Proper pump rotation and speed.
4. Seal adjustment (where applicable).
5. Running clearances of impeller and other rotating parts.
6. Motor load.

D. After one hour of operation at operating temperature but not more than four hours after startup, recheck pump drive alignment.

E. Adjust impeller clearance where required. Check for any sign of overheating of motors, bearings, seals, etc. Blow down suction strainer.

F. Demonstrate all features of the control system including interlocks, diagnostics, flow, and cycle indications.

G. After one week of operation, remove start-up strainer from suction strainer, if any.

H. The Construction Representative will observe startup and contractor testing of the equipment.

1. Coordinate the startup and contractor testing schedules with the Construction Representative.
2. Contractor shall provide a minimum of 10 working days notice prior to startup and testing.

3.5 TESTING, ADJUSTING, AND BALANCING

A. Following initial running of individual pumps to demonstrate satisfactory mechanical operation, complete operational testing, adjusting, balancing, and associated documentation to demonstrate pump performance as part of its respective system.

3.6 DEMONSTRATION AND TRAINING

A. Provide the services of manufacturer’s technical representative for a minimum of two four hour training sessions to instruct Owner’s personnel in operation and maintenance of the system.

END OF SECTION 232519.40

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The requirements of this section are applicable to all work performed under Division 26 – Electrical.

1.3 COORDINATION

A. It is the intent of the Electrical Division of these Specifications that all electrical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations shall operate as designed.

B. Provide a complete operational electrical system. Route conduit and install equipment to avoid conflicts with other trades and to enhance maintainability of system.

C. All construction work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.

D. The Owner intends to make continued use of existing facilities. Utilities and services to existing facilities shall not be interrupted without the Owner's approval as to the time and duration. The Owner will continue to occupy the existing facilities throughout the construction operations, and the Contractor shall so organize his work as to cause a minimum of interference with the normal routine activities of the facilities. All interruptions shall be scheduled at the convenience of the Owner.

E. The Contractor shall coordinate his work so there shall be no prolonged interruptions of existing equipment and all interruptions of utilities must be scheduled with the Owner. In no case shall any utilities be left disconnected at the end of a work day or over the weekend.

F. Any interruptions of any utilities either intentionally or accidentally shall not relieve the Contractor responsible from repairing and restoring the utility to normal service. Repairs and restoration shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

G. The Contractor's area for construction shall be as shown on the Drawings.

H. The Contractor shall maintain access to the Owner's facilities during construction by keeping clear the drives in the construction area. Any blockage of the drives shall be scheduled with the Owner.

I. This project will involve several contractors in addition to this Contractor. There may also be contractors not associated with this project working in the vicinity.

J. This Contractor shall cooperate fully with the other contractors in the conduct of the work. Such cooperation with regard to work schedules, area of work, etc., is to be a normal part of this type of project and no extra compensation will be allowed for it.

1.4 DEFINITIONS

A. Concealed: Where the word “concealed” is used in conjunction with raceways, equipment, and the like, the word shall be understood to mean hidden from sight as in chases, furred spaces, or above suspended ceilings.

B. Exposed: Where the word “exposed” is used, the word shall be understood to mean open to view.

C. Provide: Where the word "provide" is used, in the Specifications or on the Drawings, it shall mean "furnish and install" unless otherwise noted or specified.

D. Related Work: The sections referenced under RELATED SECTIONS shall be understood to include provisions which directly affect the work being specified in the section where RELATED SECTIONS occurs.

E. The Work: Where the words “the Work” are used together, they shall be understood to mean the work under contract that is governed by these Specifications and the Drawings.

1.5 SUBMITTALS

A. The Contractor shall submit to the Designer for approval, prior to fabrication and in accordance with the procedures outlined in Section 013300 – Submittals, all submittals as required by each Section in this Division of these Specifications.

B. Each submittal shall be properly identified as to the specific equipment to which it relates. Identification on the submittal shall be by reference to equipment identification numbers as shown on the Drawings and, if applicable, by reference to the appropriate Article of the Specifications in which the equipment is specified.

C. Shop drawings, brochures, or manufacturer's product data sheets showing more than one size or model shall be marked to indicate the size or model proposed for the particular application.

D. All submittals shall be certified by the Contractor as being correct for the proposed work.

E. Submittals in the form of shop drawings shall include complete data on the equipment to be provided, including physical dimensions and other information required for installation, performance capabilities and limitations, and schedules indicating locations when more than one type of an item is to be used.

F. Prior to submittal, shop drawings shall be coordinated with the work of all other trades.

G. Any and all submittals that do not comply with all of the above requirements will be rejected and returned without review.

H. Provide operating instructions and maintenance manuals in accordance with Section 013300 – Submittals, Section 007213 – General Conditions and 007300 – Supplementary Conditions.

1.6 RECORD (AS-BUILT) DRAWINGS

A. The Contractor shall update a complete set of the construction drawings, shop drawings and schedules of all work daily by marking changes, and at the completion of their work

(prior to submission of request for final payment) note all changes and turn the set over to the Construction Representative in accordance with Section 007213 – General Conditions. The updates shall show all addenda, all field changes that were made to adapt to field conditions, changes resulting from contract changes or supplemental instructions, and all locations or structures. All concealed items both inside and outside shall be accurately located and referenced to permanent features such as interior or exterior wall faces and dimensions shall be given in a neat and legible manner in a contrasting colored pencil or ink. If approved by the Designer, an electronic file format may be provided.

B. No deviations from the Contract Drawings or approved shop drawings shall be made without prior approval from the Designer or Construction Representative.

1.7 REFERENCE STANDARDS

A. Included as a basic part of these Specifications are the applicable regulations of the standards listed below. Portions of all of certain recognized industry or association standards referred to herein as being a requirement of these Specifications shall be considered as binding as though reproduced in full herein. Unless otherwise stated, the reference standard shall be the latest edition of the standard which is current as of the date of issuance of the Contract Documents. Where conflicts exist from one code to another, the more stringent requirement shall apply.

B. Referenced Codes and Standards constitute minimum requirements and strict compliance is required therewith unless supplemented and/or modified by more stringent requirements in these Specifications.

C. Reference may be made to standards either by full name or by letter designation as follows:

1.	AHDGA	American Hot Dip Galvanizers Association, Inc.
2.	AISC	American Institute of Steel Construction
3.	ANSI	American National Standards Institute
4.	ASA	American Standards Association
5.	ASTM	American Society for Testing & Materials
6.	AWS	American Welding Society
7.	BOCA	Building Officials and Code Administrators International, Inc.
8.	CSA	Canadian Standards Association
9.	EEI	Edison Electric Institute
10.	EIA	Electronics Industries Association
11.	ETL	Electrical Testing Laboratories, Inc.
12.	FMRC	Factory Mutual Research Corp
13.	IACS	International Annealed Copper Standard
14.	IBC	International Building Code
15.	IBEW	International Brotherhood of Electrical Workers
16.	ICC	International Code Council
17.	ICEA	Insulated Cable Engineers Association
18.	IEC	International Electrotechnical Commission

19.	IEEE	Institute of Electrical and Electronics Engineer
20.	IFC	International Fire Code
21.	ISA	The Instrumentation, Systems, and Automation Society
22.	JIC	Joint Industrial Council
23.	NBFU	National Board of Fire Underwriters
24.	NEC	National Electrical Code (NFPA 70)
25.	NECA	National Electrical Contractors Association
26.	NEMA	National Electrical Manufacturers Association
27.	NETA	InterNational Electrical Testing Association
28.	NFPA	National Fire Protection Association
29.	NIST	National Institute of Standards and Technology (formerly National Bureau of Standards, NBS)
30.	OSHA	Occupational Safety and Health Administration
31.	UL	Underwriters' Laboratories, Inc.

1.8 REGULATORY LAWS, ORDINANCES, CODES AND STANDARDS

A. The governing federal, state, and local laws, codes and standards in effect at the project site constitute the minimum requirements for all electrical work, and strict compliance therewith is required unless supplemented and/or modified by more stringent requirements of the Contract Documents.

B. All work under this Contract shall be performed in full compliance with the 2023 edition of the National Electrical Code (NEC) NFPA-70.

C. The Contractor shall keep a copy of the 2023 NEC on the project site for his reference at all times.

D. Requirements in reference specifications and standards are a minimum for equipment, material, and work. In instances where capacities, size, or other features of equipment, devices, or materials exceed these minimums, meet specified or scheduled capacities.

E. Resolve code interpretations discovered in Contract Documents with Designer prior to Contract award. After Contract award, make corrections or additions necessary for compliance with applicable codes.

1.9 CONTRACT DRAWINGS

A. Included under Section 000115 – List of Drawings of these Specifications are the Drawings which indicate in general the character, arrangement, and construction of equipment and materials called for in these Specifications.

B. Drawings are generally diagrammatic and are intended to encompass a system that will not interfere with other systems or the structural and architectural design of any building or structure. Coordinate work to avoid interferences between other systems or between conduit, piping, equipment or structural or architectural elements of any building or structure.

C. Drawings are based on preliminary information obtained from a manufacturer of the equipment specified. Make adjustments, modifications, or changes required, based on the shop drawings furnished by the manufacturer of the equipment to be furnished on this project.

1.10 WORKMANSHIP

A. All work shall be done under the supervision of the Contractor who shall provide competent foremen to lay out all work. All work shall be laid out with due regard for proper working clearances about electrical equipment in accordance with NEC Article 110 and the space requirements of other contractors. The Contractor shall immediately report to the Construction Representative any conflict or difficulties with regard to the installation.

B. The Contractor shall be completely responsible for all work installed by him and shall employ only competent and experienced personnel of proper trades to perform the work.

C. All work shall be installed so as to be accessible for operation, maintenance, adjustment, replacement, and repair with particular attention given to locating controls and other items requiring periodic lubrication, cleaning, adjusting, or servicing of any kind.

D. Local disconnect switches, control stations, conduit drops, control panels, electrical enclosures, instrumentation, etc. shall be located so as not to interfere with access required for the necessary service and operation of equipment and shall meet the working clearance requirements of Article 110 of the National Electrical Code.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Only NEW, clean and perfect equipment, apparatus, materials, and supplies of latest design and manufacture shall be incorporated in the work in order to assure an electrical system of high quality.

B. All materials shall be new, shall be installed according to manufacturer's specifications or as directed by the Designer, and shall be listed and labeled by Underwriters' Laboratories, Inc. (UL) or other nationally recognized testing laboratory (NRTL).

C. All materials and equipment furnished under these Specifications shall be standard products of the various manufacturers except where special construction or performance features are called for. Where more than one of the specific items is required, all shall be of the same type and by the same manufacturer.

D. The product of a manufacturer shall be acceptable only when that product complies with or is modified as necessary to comply with all specified and indicated requirements in the Contract Documents.

E. Materials and equipment not herein specified or indicated as to manufacturer but necessary for complete functioning systems shall be provided from sources conforming to the quality levels and functional requirements for corresponding materials and equipment set forth herein.

F. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced by the Contractor to the full satisfaction of the Construction Representative.

2.2 MANUFACTURER'S EQUIPMENT NAMEPLATES

A. All equipment shall have factory applied permanent nameplates indicating the manufacturer's name, model and serial numbers, and any other data necessary to conform to specified requirements.

2.3 PAINTING AND FINISHES

A. All purchased equipment shall have a factory applied standard finish of the manufacturer's standard color unless otherwise specified.

B. Finishes which are marred during shipping, handling, or installation shall be touched up by the Contractor to match the original finish.

2.4 EQUIPMENT TAGGING

A. All equipment and materials shipped under these Specifications shall be properly tagged with the name of the item, name of the project and project address, and shall bear the Contractor's name.

PART 3 - EXECUTION

3.1 SCOPE OF THE WORK

A. The Contractor shall provide all labor, materials, equipment, tools, supervision, and services required for the complete installation of all electrical work as shown on the Drawings and described in these Specifications.

B. The work under Divisions 26 of the Specifications includes, but is not limited to, the following items:

1. Demolition of existing power and branch circuit conductors, cables, raceways, boxes, and equipment
2. Demolition of existing control conductors, cables, raceways, boxes, and devices
3. Disposal off site of the existing equipment and materials to be removed
4. Disconnection, handling, relocation, and/or reconnection of existing equipment**,** instrumentation, control panels and rerouting of existing control and instrumentation circuits and power feeders as required and as shown on the Drawings
5. All feeder and branch circuit wiring, raceways, boxes, equipment and devices
6. All control conductors, cables, raceways, boxes, and devices
7. Grounding and bonding
8. Junction and pull boxes
9. Fuses and circuit breakers
10. All motor power and control circuit wiring, raceways, equipment, and components

11. Protective device coordination study and arc flash risk assessment

C. The Contractor shall furnish and install all control and power wiring required to properly operate the new packaged water treatment system including all control panels. It may become necessary to modify the interconnecting control wiring from that shown on the Drawings in order to accommodate the control system diagrams provided by the manufacturers of the systems. To this extent, the Contractor shall make all such accommodations at no additional cost to the Owner.

D. The requirements for integration into the building automation system for control and/or monitoring of the new mechanical equipment is covered under Division 23 – Heating, Ventilating and Air Conditioning (HVAC).

3.2 SHIPMENT AND DELIVERY

A. The Contractor shall be responsible for the furnishing and safe delivery of all materials and equipment required for the project and for the safekeeping of all material and equipment until final acceptance by the Construction Representative.

B. The Contractor shall be responsible for protecting all electrical equipment intended exclusively to function indoors. Such equipment must be stored indoors and protected against exposure to or accumulation of dust, moisture, freezing, flooding, corrosion or other form of damage. The Contractor shall clean and restore damaged finishes as required to place the installation in a "like new" condition before acceptance by the Owner.

3.3 SAFETY MEASURES

A. The Contractor shall arrange his work in such a manner that a minimum of interference will be experienced with the operations of the Owner or with traffic, both pedestrian or vehicular, either in the vicinity of or on the project site.

B. The blocking of thoroughfares shall be kept to a minimum and shall be coordinated with the Construction Representative and authorities have jurisdiction.

C. The Contractor shall comply with the U.S. Department of Labor-Occupational Safety and Health Administration (OSHA) - Occupational Safety and Health Standards, all local and state public safety regulations and provide such safety measures as signs, signals, road blocks, safety lights, railings, guards, temporary walkways, crossings and similar safety equipment as may be required for the adequate protection of the public, the Owner's personnel, workmen engaged on the project, and property.

3.4 WORK VERIFICATION AND FIELD MEASUREMENTS

A. The Contractor shall verify the voltage, phase, full-load current and exact location of all electrical equipment before rough-in.

B. The Contractor shall note that the configuration and dimensions of actual equipment may vary from that shown on the Drawings depending on the equipment supplied. The Contractor shall be responsible for making the necessary modifications to connecting conduit, bases, etc. required by the equipment supplied.

C. All dimensions and clearances affecting the installation of work shall be verified at the project site in relation to established datum, to existing items and conditions, and to the work of other trades.

D. The Contractor shall assume responsibility for proper installation of materials in the space available.

E. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

F. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Construction Representative and/or Designer shall be notified, and any changes shall be approved before proceeding with the Work.

G. Where crowded locations exist and where there is a possibility of conflict between the trades, the Contractor shall make composite drawings showing the exact locations of the items in question (pipes, ducts, conduits, equipment, etc.). Drawings shall be based on actual measurements, after consultation and agreement between the trades, and shall be approved by the Designer before installation of the Work.

H. The Contractor shall provide all necessary offsets, raises or drops in conduits and fixtures as required by existing conditions at no additional cost to the Owner.

I. The location of all items shall be obtained from the Drawings. The Construction Representative and/or the Designer shall be allowed to relocate any item within a 10-foot radius from the scaled location on the plans without additional cost to the Owner, provided this is done prior to or during rough-in and before finish installation.

3.5 ELECTRICAL WORK DEMOLITION AND RELOCATION OF EXISTING EQUIPMENT

A. See Section 260505 – Selective Demolition for Electrical in these Specifications.

3.6 MOUNTING HEIGHTS

A. Unless otherwise indicated elsewhere in these Specifications or Drawings, mounting heights of electrical equipment shall be in accordance with the following schedule.

B. The following item mounting heights shall be above finish floor/work platform to the top of the item.

Item			Mounting Height
1.	Enclosed switches		
	a.	30-60-100A	5 feet 6 inches
2.	Control panels		
	a.	36” high or less	5 feet 6 inches
	b.	Greater than 36” high	6 feet 0 inches

3.7 FASTENING TO BUILDING STRUCTURES

A. The methods of attaching or fastening equipment, equipment supports, raceways, or hangers to building structures shall be subject to approval by the Construction Representative at all times.

B. Support of electrical equipment and raceways shall be provided in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.

3.8 CUTTING, PATCHING AND REPAIRING

A. The Contractor shall be responsible for all cutting required for and resulting from the installation of his work, except where noted otherwise. The Contractor shall patch and repair the holes and restore the surface finish.

B. The Contractor shall place sleeves for conduits that must pass through foundations, walls, and slabs ahead of concrete pouring. Failing in this, the Contractor shall do the necessary cutting and sealing thereafter in an approved manner.

C. Under no circumstances shall any structural members, load bearing walls, building columns or footings be cut without first obtaining written permission from the Designer.

D. Cutting shall be in accordance with the following.

1. Concrete and Masonry: All openings for conduit shall be core drilled. Square or rectangular openings shall be saw cut.

E. Patching shall be in accordance with the following.

1. Non-fire Rated Concrete and Masonry: Patch the opening with Sika Top 122 Plus (Sika Corp.) non-shrink grout or approved equal, finished smooth with adjacent surface.

2. Fire-rated Construction: In accordance with Section 260533.13 – Conduit for Electrical Systems.

3.9 ELECTRICAL TESTS

A. The Contractor shall, after the installation is completed, visually inspect all items to ascertain that each item is not damaged and is in proper working condition, and shall test all circuits and demonstrate to the satisfaction of the Construction Representative and/or Designer, the following:

1. That all power and control circuits are continuous and free from short circuits and unspecified grounds.

2. That the resistance to ground of all ungrounded circuits operating below 600 volts is 50 megohms or greater at a test voltage of 1000 VDC.

3. That all circuits are properly connected to the correct phase and in accordance with the Drawings and applicable wiring diagrams. Circuits shall be numbered as shown on the Drawings and connected to equalize the loading on all phases.

4. That all circuits and equipment are operable. Demonstration shall include the proper functioning and operation of each unit to the Owner's satisfaction, and the continuous operation of all power circuits for not less than 24 hours.

5. That all equipment requiring calibration and adjustment has been properly calibrated and adjusted in accordance with its intended function and the manufacturer's recommendations.

6. That all equipment and systems function properly.

7. That the phasing sequence and synchronization is the same throughout the entire electrical system. The Contractor shall be responsible for the correct phase rotation on all motors and devices. Any item that is damaged as a result of improper rotation or phasing shall be replaced by the Contractor at no additional cost to the Owner.

B. All tests shall be made after notification to and in the presence of the Construction Representative and/or Designer and the authorities having jurisdiction, if required.

C. The cost of labor, materials, instruments and supplies of any kind required for testing shall be borne by the Contractor.

D. Before starting up any system, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, continuity of controls, and any other condition which could cause damage to equipment or endanger personnel.

E. Test runs shall be made over the full design load range where possible, or simulated to the satisfaction of the Construction Representative for other conditions. During test runs all necessary adjustments shall be made, controls checked for proper operation, motors checked for possible overload, and the entire system checked by the Contractor for any abnormal condition.

F. During the test runs and prior to acceptance of any system, the Owner’s designated operating personnel shall be instructed in the operation and maintenance of the system.

G. Material and equipment damaged or shown to be defective during tests, unable to perform at design or rated capacity, or not in accordance with the Specifications shall be repaired or replaced by the Contractor to the full satisfaction of the Construction Representative at no cost to the Owner.

3.10 START UP

A. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Construction Representative.

B. The Contractor shall provide qualified personnel to perform start up assistance and final acceptance testing of all equipment after it has been completely installed and is ready to be energized, prior to applying voltage.

C. The Contractor shall be responsible for the operation and maintenance, including all costs thereof, for systems or equipment temporarily placed in operation for testing and adjusting purposes, or for the convenience or necessity of the Contractor prior to final acceptance by the Owner.

D. The Contractor shall instruct the Owner’s operating personnel in the operation and maintenance of the electrical equipment during energization but prior to acceptance by the Owner.

3.11 TEMPORARY POWER

A. Provide temporary power, form source(s) designated by Construction Representative, to maintain operation of equipment when normal power source must be disconnected for execution of the Work.

B. All temporary power shall be in compliance with the NEC and applicable OSHA regulations and shall be maintained and removed by the Contractor when no longer required.

END OF SECTION 260500

SECTION 260505 – SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. This Section includes demolition and removal of selected portions of facility required for new construction.

1.3 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment and services necessary to perform all electrical demolition work.

B. Work included in this Section includes all demolition work as shown on the Electrical Drawings and as specified herein and as required to complete the Work.

1.4 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

1.5 DEFINITIONS

A. Demolish: Completely remove and legally dispose of off-site.

B. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

C. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

D. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

E. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

F. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner. Include fasteners or brackets needed for reattachment elsewhere.

1.6 SUBMITTALS

A. Schedule of Selective Electrical Demolition Activities: Indicate detailed sequence of selective electrical demolition and removal work, with starting and ending dates for each activity and interruption of electric power services.

B. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

C. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective electrical demolition operations. Submit before the Work begins.

D. Disposal Records: If hazardous wastes are removed by Contractor, submit the following:

1. Hazardous Waste Transporter license
2. Permit or license for hazardous waste treatment or disposal facilities
3. Completed Uniform Hazardous Waste Manifest for all shipments
4. Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

C. Prior to beginning demolition, arrange a conference with the Construction Representative to review electrical demolition scope, procedures, schedule and items to be salvaged for the Owner.

1.8 PROJECT CONDITIONS

A. Owner will occupy the facility during construction. Localized areas to be demolished will be vacated during demolition work. Conduct selective electrical demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Construction Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Utility Service: Maintain electrical service to building during selective electrical demolition operations.

1. Disconnect electrical power only to the items of equipment or the panelboard that is identified for removal under the selective electrical demolition operations.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.10 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner’s property, demolished materials shall become the Contractor’s property

and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

B. On-site storage or sale of removed items or materials is not permitted.

1.11 COORDINATION

A. Arrange demolition schedule so as not to interfere with Owner's on-site operations and the operations of adjacent occupied buildings.

B. Review and finalize selective electrical demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

C. Review requirements of General Demolition Contractor and work performed by other trades that rely on demolition of electrical circuitry or equipment to allow for structural demolition or removal of equipment.

D. Review areas where existing electrical circuitry and/or equipment is to remain in place and requires protection.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

A. Verify that utilities have been disconnected and capped before starting selective electrical demolition operations.

B. Survey existing conditions and coordinate and identify the extent of the electrical demolition work required. Record existing conditions using preconstruction photographs.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

D. When unanticipated site, mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Construction Representative and Designer.

E. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

A. No electrical demolition work shall be performed without prior approval of the Construction Representative.

B. Electrical demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.

C. Any electrical demolition work which interferes with Owner's operation shall be scheduled with the Construction Representative and be subject to the Owner's approval.

D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.

E. Do not interrupt existing electrical service to occupied facilities except when authorized in writing by the Construction Representative.

F. Provide temporary electrical service during interruptions to existing electrical systems, as acceptable to the Construction Representative.

G. Unless noted otherwise, provide not less than two weeks' notice to the Owner if shutdown of electrical service is required during the execution of the work.

H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Construction Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective electrical demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. Existing building openings may be used to remove material. No new openings may be made without approval of the Construction Representative.

3.4 PROTECTION

A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during electrical demolition operations.

B. Provide dust control and ventilation as required in areas of electrical demolition.

C. Execute electrical demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas; maintain free and safe passage of persons around the areas of electrical demolition.

D. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the electrical demolition work.

E. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.

F. Protect existing surfaces, active utility services, and equipment which are to remain in place.

G. Protect lighting fixtures, exit signs, fire alarm devices, and other items that are to remain in place from damage during demolition and construction operations. Exposed fixtures and devices shall have a plastic bag or other suitable covering affixed over the item to protect from dust and paint splatters.

3.5 DUST CONTROL

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's property.

B. Adequacy of the dust control methods shall be subject to the approval of the Construction Representative.

C. Areas of major electrical demolition inside the Owner's property shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.

D. Temporary enclosures shall be removed by the Contractor upon completion of the electrical demolition work unless otherwise directed by the Construction Representative.

3.6 ELECTRICAL DEMOLITION - GENERAL

A. Remove all work indicated on the Drawings and as required to complete the new work indicated.

B. During electrical demolition operations, keep areas adjacent to electrical demolition work free of dust and debris.

C. During electrical demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Construction Representative.

D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting electrical demolition operations.

E. Neatly cut openings and holes plumb, square and true to dimensions, required.

F. Use cutting methods least likely to damage construction to remain or adjoining construction.

G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

I. Do not use cutting torches until work area is cleared of flammable materials.

J. Maintain portable fire-suppression devices during flame-cutting operations.

K. Contractor shall take care when using a torch to cut steel welded or bolted to structural members so as to cut flush with but not damage the structural members.

L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.

M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.

N. Locate selective electrical demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

O. Dispose of demolished items and materials promptly.

3.7 ELECTRICAL DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality and functionality.

B. The Contractor shall use caution in the demolition of electrical systems and shall inform himself of the status (active, inactive) of all electrical systems to be demolished prior to proceeding.

C. Prior to breaking or cutting conduit within the demolition area, the Contractor shall ascertain that the system has been identified or shown on the Drawings to be wrecked under this Contract. Contact the Construction Representative for clarification prior to demolishing or wrecking questionable items.

D. The Contractor shall remove, cap and/or relocate equipment, outlets, lighting fixtures, conduit, wire, etc., as specified or as shown on the Drawings and as may become necessary because of existing field conditions at no additional cost to Owner.

E. All existing lighting fixtures, switches, receptacles, outlets, etc., shall be removed as required to complete the work and blank covers provided over the outlets, unless otherwise noted.

F. Properly dispose of all lighting fixture lamps and ballasts in accordance with all applicable Federal, State, and local laws and regulations.

G. All concealed conduit for circuits which are partially or completely abandoned may remain in place. Remove all wiring for concealed circuits that are to be completely abandoned and cut and remove concealed conduit 2 inches below the surface of adjacent construction. Cap conduits and patch surface to match existing finish and fire rating. Exposed conduit for abandoned circuits shall be removed, unless otherwise noted.

H. Exposed conduit containing circuits which are to be retained shall remain in place, unless otherwise indicated or required.

I. Wiring for existing circuits which must be rerouted, or which are partially abandoned, shall be reconnected to service the outlets/loads remaining on the circuit.

J. All wiring for a circuit which is to be removed or abandoned shall be removed back to the panel which supplied the circuit.

K. Completely remove all hangers and supports to building structure. Grind off stubs without damaging parent material (steel, concrete, etc.) and touch up paint as required.

L. All abandoned or remaining empty conduit with open ends resulting from demolition work shall be promptly capped, plugged, or sealed.

M. All open conduit knockouts, holes or unused hubs in electrical boxes and enclosures shall be properly plugged with suitable blanking devices that maintain the NEMA rating of the box or enclosure. Utilize NEMA 12 rated hole seal devices to seal all open holes in the top of all panelboards, switchboards, motor control centers and dimensioned junction and pull boxes located indoors.

3.8 CONCRETE AND MASONRY DEMOLITION

A. Demolish concrete and masonry in small sections.

B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

3.9 PATCHING

A. All holes or openings in floors, walls or ceilings resulting from electrical demolition shall be properly sealed with material similar to the adjacent surface/finish. Patch holes in concrete floors and ceilings where conduits are removed using non-shrink epoxy grout or concrete material to match existing surfaces and construction. Patch holes in walls and partitions where conduits are removed to match existing construction and finish.

B. All rough edges of openings created by electrical demolition shall be promptly patched to create a finished surface.

C. Openings in concrete shall be patched with cement mortar.

D. Openings in masonry shall be patched by toothing in masonry units to match existing.

E. Maintain the fire rating of all floors, walls, partitions and ceilings when patching.

3.10 REMOVED AND SALVAGED ITEMS

A. Carefully remove and clean salvaged items.

B. Pack or crate items after cleaning. Identify contents of containers.

C. Store items in a secure area until delivery to Owner.

D. Transport items to Owner's storage area as directed by Construction Representative.

E. Protect items from damage during transport and storage.

3.11 REMOVED AND REINSTALLED ITEMS

A. Carefully remove items to be reinstalled.

B. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

C. Pack or crate items after cleaning and repairing. Identify contents of containers.

D. Protect items from damage during transport and storage.

E. Reinstall items in locations indicated.

F. Comply with installation requirements for new materials and equipment.

G. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

H. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

3.12 EXISTING ITEMS TO REMAIN

A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective electrical demolition.

B. When permitted by Construction Representative, items may be removed to a suitable, protected storage location during selective electrical demolition and reinstalled in their original locations after selective electrical demolition operations are complete.

3.13 DISPOSAL

A. All debris resulting from electrical demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Construction Representative.

B. Storage of removed materials on site will not be permitted.

C. Sale of removed materials on-site will not permitted.

D. Transport demolished materials off Owner’s property and dispose of legally in accordance with Federal, State, and local laws and regulations.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.14 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective electrical demolition operations.

B. Return adjacent areas to condition existing before selective electrical demolition operations began.

3.15 HAZARDOUS MATERIALS

A. The Owner, to the best of his knowledge, has identified hazardous materials such as friable asbestos and/or lead based paint in the work areas.

B. Should the Contractor discover additional material requiring removal which is suspected to contain hazardous materials, do not disturb.

C. Contact and consult with the Construction Representative prior to proceeding. The Construction Representative shall direct the Contractor how to proceed.

END OF SECTION 260505

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all conductors, wiring, and cables as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260526 – Grounding and Bonding for Electrical Systems

C. Section 260533.13 – Conduit for Electrical Systems

D. Section 260533.16 – Boxes for Electrical Systems

E. Section 260553 – Identification for Electrical Systems

F. Section 260583 – Wiring Connections

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for each of the following items:

1. 600-volt building wire
2. 600-volt multiconductor control cable
3. 600-volt shielded instrumentation cable
4. CAT 6 copper Ethernet cable

B. Submit test report indicating results for copper wire and cable continuity and resistance testing.

PART 2 - PRODUCTS

2.1 GENERAL

A. All cable and wire shall have copper conductors; aluminum shall not be substituted nor permitted.

B. All conductors shall be new, shall be approved and listed by Underwriters' Laboratories, Inc., (UL), shall bear UL identification, and shall have been manufactured within six months from date of the Contract. If requested by the Designer, the Contractor shall supply authenticated data from the wire manufacturer stating the manufacturing date of the wire.

C. All wire sizes are expressed in American Wire Gauge (AWG) or in circular mils. Unless otherwise indicated, all conductors shall have 90ºC rated insulation (wet or dry). The current rating of all conductor sizes shall be calculated using the correction factors and ambient temperature adjustment factors in NEC Article 310-15(B) but under no circumstance shall exceed the values listed in the 60°C temperature column of the tables for circuits 100 amps and below or the 75°C temperature column for circuits over 100 amps.

D. Conductors for all branch circuits and feeders shall be color coded in accordance with the National Electrical Code (NEC).

2.2 600-VOLT BUILDING WIRE

A. All conductors for lighting and power systems, including equipment grounding conductors and single conductor control wiring shall be copper, 600-volt, single conductor building wire.

1. Conductor: ASTM B3, annealed copper. Conductor sizes 12 and 10 AWG shall be solid, 8 AWG and larger and 14 AWG single conductor control wiring shall be stranded per ASTM B8. Minimum conductor size shall be 12 AWG except for single conductor control wiring which shall be 14 AWG.

2. Insulation: 600-volt, Flame Retardant, thermoset Cross-linked Polyethylene (XLPE) per ICEA S-95-658/NEMA WC70 Section 3; thickness per UL 44 and ICEA S-98-658/WC70, Table 3-4, Column B

3. Temperature Rating, Continuous Use: 90°C wet or dry locations

4. UL Listed: Type XHHW-2

5. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-95-658/NEMA WC70.

6. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-95-658/NEMA WC70.

7. Identification: Surface printing on the cable shall show manufacturer's name, conductor size and metal, voltage rating, UL symbol, insulation type and color per NEC Article 310-110 – Conductor Identification and Section 260553 – Identification for Electrical Systems.

8. Manufacturer: Alanwire, Cerrowire, General Cable Company, Service Wire Company, Southwire Company or approved equal.

B. Leads to special equipment shall be as recommended or supplied by the fixture or equipment manufacturer and as shown on the Drawings or as required by applicable codes.

2.3 600-VOLT MULTI-CONDUCTOR CONTROL CABLE

A. Low voltage control cable shall be copper, 600-volt, unshielded, multi-conductor control cable conforming to ICEA S-73-532/NEMA WC57.

1. Conductors: ASTM B33 and B8; Class B stranded annealed copper conforming to ICEA S-73-532/NEMA WC57. Size 18 AWG, 16 AWG or 14 AWG as indicated on the Drawings. Where no size is indicated use size 14 AWG.

2. Insulation: 600-volt, Flame Retardant, Ethylene Polyethylene Rubber (FR-EPR) Type II per ICEA S-73-532/NEMA WC57; thickness 25 mils per ICEA S-73-532/NEMA WC57, Table 3-1 or flame-retardant cross-linked polyethylene (XLPE) per ICEA S-73-532/NEMA WC57, thickness 30 mils per ICEA S-73-

532/NEMA WC57, Table 3-1. Color coding shall be ICEA Method 1, E-2. Where wire colors white and/or green are required, color coding shall be ICEA Method 1, E-1.

3. Jacket: Lead-free, Cross-linked Chlorinated Polyethylene (XL-CPE) with thickness per UL 1277 and ICEA S-73-532/NEMA WC57, Table 4-1 as follows:

   a. 14 AWG, 2 to 7 conductors: 45 mils
   b. 14 AWG, 9 to 19 conductors: 60 mils
   c. 16 AWG, 2 to 4 conductors: 45 mils
   d. 16 AWG, 5 to 12 conductors: 60 mils
   e. 16 AWG, 15 to 19 conductors: 80 mils
   f. 18 AWG, 2 to 12 conductors: 45 mils
   g. 18 AWG, 15 to 19 conductors: 60 mils

4. Temperature Rating: Cable shall be suitable for continuous use at 90°C wet or dry (ICEA S-73-532/NEMA WC57, Section 3, Paragraph 3.4.1)
5. UL Listed: Type TC Power and Control Tray Cable per UL 1277
6. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.
7. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.
8. Flame Test Certification: Passes IEEE-383 ribbon burner flame test
9. Identification: Surface printing on the cable shall show the manufacturer's name, number and size of conductors, voltage rating, UL information, insulation type, jacket type, and numbered footage markers.
10. Manufacturer: General Cable Type CHTC, or approved equal by Basic Wire and Cable, Belden, Dekoron or Okonite

2.4 600-VOLT SHIELDED INSTRUMENTATION CABLE

A. Shielded instrumentation cable with shielded twisted pairs shall be 600-volt rated conforming to ICEA S-73-532/NEMA WC57.

1. Conductors: ASTM B33 AND B8; Class B stranded coated annealed copper conforming to ICEA S-73-532/NEMA WC57, size 18 AWG or 16 AWG as indicated on the Drawings. Where no size is indicated use size 16 AWG.
2. Insulation: 600-volt, flame retardant, cross-linked, polyethylene (XLPE) per ICEA S-73-532/NEMA WC57; thickness: 25 mils per ICEA S-73-532/NEMA WC57 Table 3-1. Color coding shall be by Method 1 per ICEA S-73-532/WC57 Appendix E using color-pigmented compounds. Each pair shall have one (1) white and one (1) black conductor. When multiple pairs are used, group identification shall be by printed numbers on one conductor of each pair in consecutive order.
3. Pair Shield: Aluminized Mylar or aluminized polyester tape in contact with a tinned copper drain wire. Shields to be isolated from all other assemblies.

4. Cable Shield: Aluminized Mylar or aluminized polyester tape in contact with a tinned copper drain wire

5. Jacket: Lead-free, cross-linked, chlorinated polyethylene (XL-CPE) per ICEA S-73-532/NEMA WC57 Section 4, Paragraph 4.2 with thickness per ICEA S-73-532/NEMA WC57, Table 4-1

6. Identification: Surface printing on the cable shall show the manufacturer's name, insulation type, jacket type, number of pairs, size of conductors, voltage rating, and numbered footage markers.

7. Temperature Rating: Cable shall be suitable for continuous use at 90°C wet or dry (ICEA S-73-532/NEMA WC57, Section 3, Paragraph 3.4.1)

8. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.

9. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.

10. Manufacturer: General Cable Company Type CHTC or approved equal by Basic Wire and Cable, Belden, Dekoron or Okonite

2.5 CAT 6 COPPER ETHERNET CABLE

A. 300-volt, CAT 6 (350MHz), 4-pair, U/UTP-Unshielded, indoor/outdoor, premise horizontal Ethernet cable conforming to NEC/UL Specification CMR, CMX-Outdoor.

B. *Conductors*: Solid bare copper size 23 AWG

C. *Insulation*: 300-volt, polyolefin (PO); minimum thickness: 0.00825", nominal thickness 0.008875". Color coding shall be:

1. Pair 1: White/blue strip and blue
2. Pair 2: White/orange strip and orange
3. Pair 3: White/green strip and green
4. Pair 4: White/brown strip and brown

D. *Jacket*: Lead-free, flame-retardant, sunlight resistant polyvinyl chloride (PVC); minimum thickness 0.023", nominal thickness 0.03".

E. *Temperature Range*: -20°C to +75°C – installation, -40°C to +75°C – operating, UL temp rating 90°C

F. *Electrical Characteristics*:

1. Nominal Mutual Capacitance: 17 pF/ft
2. Maximum Capacitance Unbalance: 330 pF/100m
3. Nominal Velocity of Propagation: 68%
4. Maximum Delay: 537.6ns/100m @ 100MHz
5. Maximum Delay Skew: 35ns/100m
6. Maximum Conductor DC Resistance: 7.8 Ω/100m @ 20°C
7. Maximum DC Resistance Unbalanced: 3% @ 20°C

G. *UL Listed*: Type CMG, CMR, CMX-Outdoor

H. *Testing*: All cables shall be tested in accordance with UL 1666 Riser Flame Test and CSA Flame Test FT4

I. *Manufacturer*: Belden 2146A or approved by Basic Wire and Cable or Dekoron

2.6 600-VOLT CONNECTIONS AND TERMINATIONS

A. Provide connections and terminations for 600-volt wire and cable in accordance with Section 260583 – Wiring Connections.

2.7 CABLE PULLING LUBRICANT

A. Cable pulling lubricant shall be compatible with all cable jackets. The lubricant shall be UL Listed. The lubricant shall contain no greases, silicones, or polyalkylene glycol oils or waxes.

B. A 200-gram sample of the lubricant, when placed in a one-foot, split metal conduit and fully dried for 24 hours at 105°C, shall not spread a flame more than three inches beyond a point of ignition at a continued heat flux of 40 KW/M^2. Total time of test shall be one-half hour.

C. Cable pulling lubricant shall meet the following minimum specifications:

1. Lubricity at 200 lbs/ft Normal Pressure:

   a. PVC or XLP jacketed cable/PVC conduit
   Coefficient of dynamic friction……≤ 0.15

   b. PVC or XLP jacketed cable/HDPE duct
   Coefficient of dynamic friction……≤ 0.15

2. Percent Non-Volitle Solids……...≤ 5.5%

3. Temperature Use Range……..20°F to 110°F

4. pH…….≥ 6.5, ≤ 9.0

5. Flammability……..…..……No Flash Point

6. Polyethylene Stress Cracking……....None/ASTM D1693

7. Temperature Stability:

   a. < 10% change in Brookfield viscosity from 40°F to 100°F
   No separation after five freeze/thaw cycles or 24-hour exposure at 120°F

D. Cable pulling lubricant shall be:

1. POLYWATER® J

2. 3M WL

3. Approved equal by Ideal

PART 3 - EXECUTION

3.1 GENERAL

A. Store all conductors and cable indoors, protected from moisture.

B. Provide homerun conductors of continuous length without joint or splice from overcurrent protective device to first load termination point.

C. Provide power feeder conductors of continuous length without joint or splice for their entire length.

D. Conductors shall be continuous from source to destination without splices or taps in conduit runs, except where indicated on the Drawings to compensate for voltage drop or where required to prevent excessive pulling tension or sidewall pressure on wire or cable. Submit all proposed splice locations to the Designer for approval prior to pulling wire and cable. Where permitted, splices shall be mechanically strong and have an insulation value equal to the wire or cable being spliced. All splices and taps shall be contained within NEC sized junction boxes meeting the requirements of Section 260533.16 – Boxes for Electrical Systems.

E. All conductors and cables shall be in a raceway (conduit, duct, etc.) approved by the Designer, unless otherwise indicated.

F. Install conductors and cable with adequate bending radius in accordance with the National Electrical Code and the conductor and cable manufacturer's recommendations:

1. Greater than six (6) times the conductor and cable outside diameter for 600-volt and below wire and cable.

G. Swab the inside of conduit and raceways to insure they are dry and clean before conductors or cables are pulled. Care shall be exercised in pulling to avoid damage to the conductors or cables. Pull all conductors into a conduit at the same time. An approved type of wire pulling lubricant, UL Listed for the application, shall be used.

H. All conductors and cables shall be installed directly from reels or coils. Conductors and cables shall not be pulled along the floor or ground or subjected to treatment that may cause abrasion or other damage to conductor and cable insulation.

I. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that do not damage the conductor, cable or raceway.

J. All conductors and cables shall be installed as recommended by the manufacturer. The manufacturer's recommended maximum pulling tension and minimum bending radius shall be adhered to during installation. Utilize the necessary guides, pulleys, sleeves, and pulling aids to prevent abrasion and damage to the conductors or cables during installation. Monitor pulling tensions and associated sidewall pressures to prevent damage to conductors and cables.

K. Provide individual dedicated full size neutral for each and every branch circuit.

L. Neatly train and lace wiring inside boxes, panelboards, switchboards and motor control centers. Group and tie single conductors of a circuit together at a minimum of 2-foot intervals. Provide supplemental structural members and materials as required to support wire and cable

without transmitting strain to connection points. Group and tie single conductors of a circuit together at a minimum of 2-foot intervals.

M. Remove and discard conductors and cables cut too short or installed in wrong raceway. Do not install conductors or cables which have been removed from a raceway.

N. Do not install conductors or cables in conduit which contains wiring already in place.

O. Do not exceed NEC limits on conduit fill.

P. Conductors terminating in outlet or device boxes shall have at least 8 inches of free conductor left inside the box.

Q. Conductors for power shall not be smaller than size 12 AWG except wire supplied with equipment by the equipment manufacturer. Conductors for control wiring shall not be smaller than size 14 AWG unless otherwise indicated.

R. Leads to special equipment shall be as recommended or supplied by the equipment manufacturer and as shown on the Drawings or as required by the applicable codes.

3.2 WIRING SEGREGATION

A. Isolate and segregate power wiring circuits from control and instrumentation wiring circuits in conduit runs, boxes, panels, and equipment.

B. Isolate and segregate "normal" power circuits from "emergency" power circuits in conduit runs, boxes, panels, and equipment.

C. Isolate and segregate lighting and convenience receptacle wiring circuits from power, control, and instrumentation wiring in conduit and boxes.

D. Isolate control wiring circuits from instrumentation wiring circuits in conduit runs and boxes.

E. In boxes, provide isolation and segregation by rigid conduit chase through box interior or continuous metal dividers of same material as the box.

3.3 ETHERNET CABLE INSTALLATION

A. Comply with ANSI/TIA-568.C.1.

B. Terminate all conductors. No cable shall contain unterminated elements. Make terminations only at cable connection points at equipment. Pairs shall not be untwisted more than 0.5 inches when terminating.

C. Cable placement shall conform to industry standards with regard to anchoring, cable support and separation from other facilities.

7. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames and terminals.

8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer’s limitations on bending radii. Use lacing bars and distribution spools.

10. Cables shall not sag or droop but shall be installed so as to maintain a flat plane with smooth transitions from one level or direction to another.

D. All Ethernet cable shall be installed in metal conduit in accordance with the requirements of Section 260533.13 – Conduit for Electrical Systems.

E. Install cable without damaging conductors or cable jacket.

1. Do not install bruised, kinked, scored, deformed, or abraded cable.

2. Remove and discard cable if damaged during installation and replace with new cable.

F. Cables shall not be spliced. Do not splice cable between termination, tap, or junction points.

G. Bring cable to a minimum of 60˚F before de-reeling. Heat lamps shall not be used for warming cable.

H. Provide additional slack at both ends of cables to accommodate future cabling system changes.

1. Do not store slack in bundled loops. Slack shall be stored in fixture-8 configuration in an extended loop. Store slack above lay-in ceiling where possible.

2. Leave 24-inches slack on each cable at each equipment panel.

I. Do not bend cable in handling or installation to smaller radii than minimums recommended by manufacturer.

J. Contractor shall be responsible for verifying the actual footages and distances identified on the Drawings.

K. Install components as indicated and according to the manufacturer's written instructions. Use techniques, practices and methods that are consistent with the requirements of the Category rating of the components.

L. Provide minimum separation of cables from EMI sources in accordance with the cable manufacturer's recommendations.

M. Test and verity cable installation after terminating at both ends in accordance with industry standards and the manufacturer's recommendations for the Category rating of the components.

N. *CAT 6 Ethernet Cable Installation*: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

1. Comply with ANSI/TIA-568-C.2.

2. Do not untwist cables more than 0.5 inches from the point of termination to maintain cable geometry.

3. Test and verify cable installation after terminating at both ends in accordance with industry standards and the manufacturer's recommendations for the Category rating of the components.

3.4 WIRING CONNECTIONS AND TERMINATIONS

A. Provide connections and terminations for 600-volt wire and cable in accordance with Section 260583 – Wiring Connections.

3.5 FIELD QUALITY CONTROL

A. General:

1. Testing shall be performed in the presence of Construction Representative. Contractor must provide 48 hours' notice prior to conducting tests.

2. Prepare a test report upon completion of testing activities. Report format shall include the following information:

a. Summary of test results

b. Test equipment summary (model number, accuracy, calibration date)

c. Test personnel names and signoffs

d. Completed data sheets

e. Test log and observations

f. Certificate of Compliance

B. Inspect wire and cable for physical damage and proper connection.

C. Verify that all power conductors are properly phased throughout the electrical system.

D. Torque test conductor connections and terminations to manufacturer's recommended values.

E. Perform continuity tests.

F. Perform and record results of megger tests for each phase and neutral conductor for each feeder. Include actual recorded megaohm value for each conductor of each feeder in the feeder conductor insulation test report.

G. Provide testing for connections and terminations for 600-volt wire and cable in accordance with Section 260583 – Wiring Connections in conjunction with the testing specified herein.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish, install, and test the grounding systems as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 260533.13 – Conduit for Electrical Systems

D. Section 260533.16 – Boxes for Electrical Systems

E. Section 260583 – Wiring Connections

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Grounding conductors
2. Grounding clamps
3. Grounding connectors

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. All grounding conductors shall be insulated, stranded copper, and unless otherwise indicated, shall meet the same specifications, in accordance with Section 260519 – Low-Voltage Electrical Power Conductors and Cables, as the accompanying circuit conductors.

B. Aluminum shall not be substituted for copper in grounding conductors.

2.2 GROUNDING CONNECTORS

A. Grounding conductor connections to equipment frames, equipment enclosures, and equipment ground lugs shall be made using corrosion resistant compression, bolted, or split-bolt connections. Bolts for equipment ground lugs shall be copper alloy terminal with a twin clamping element. Bolts for equipment enclosures shall be silicon bronze with lock washers. Use products by Burndy Corp., O-Z/Gedney, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. The entire electrical system and all electrical equipment shall be grounded in strict accordance with Article 250 of the National Electrical Code and as shown on the Drawings.

B. The grounding system shall be continuous throughout the electrical system.

C. Insulated grounding conductors shall be identified with green colored insulation or marking tape in accordance with Section 260553 – Identification for Electrical Systems and NEC Article 250-119.

D. Grounding conductors shall be continuous with no splices.

E. Protect grounding conductors against unraveling, caging, and abrasion by several wrappings of plastic tape on all ends, where cable leaves concrete, and at necessary intermediate points.

F. Install individual grounding conductors so as not to be entirely encircled or closely encircled by magnetic material.

G. Suitably protect grounding conductors against damage during construction. Replace or suitably repair at the discretion of the Designer or Construction Representative if cable is damaged by anyone before final acceptance.

H. When a conduit, which is fabricated of magnetic materials (e.g., steel conduit), contains only grounding conductors, the grounding conductors shall be bonded to the conduit at both ends of the conduit run, using grounding bushings with a bonding jumper installed between each grounding conductor and the bushing.

I. All neutral conductors shall be continuous throughout the electrical system and shall be grounded only where indicated on the Drawings or as specified herein.

J. All metallic conduits shall be properly grounded.

K. All flexible conduits shall contain a properly connected green insulated copper grounding conductor, sized in accordance with National Electrical Code, Article 250, unless otherwise indicated.

L. Flexible conduits 1-1/2" size and larger shall have an insulated stranded copper grounding conductor sized per the NEC installed external to the conduit and bonded to grounding type conduit connectors on each end of the conduit. The grounding conductor shall be secured to the conduit using nylon cable ties at 12" intervals. Cut off excess cable tie. Do not leave sharp edges.

M. A properly sized green insulated copper equipment grounding conductor shall be installed in each and every conduit.

N. All flexible cords shall contain an insulated grounding conductor, color coded green, which shall be properly connected at each termination.

O. All electrical enclosures, panels, boxes, conduits, equipment frames and other non-current-carrying metallic objects shall be grounded and bonded as required by the NEC.

P. 480V, 3-phase, grounded B-Phase power systems shall not have a fuse installed in the grounded (B-Phase) conductor and the grounded conductor shall be identified with white or gray vinyl tape at all equipment and termination points.

Q. *Connections:* All grounding conductor connections shall be made in accordance with the manufacturer's written instructions. Chemically degrease and dry completely before exothermically welding. Make up bolted connections clean and tight. All connections shall be low resistance with a resistance drop of less than 1 ohm.

R. Grounding conductors and bonding jumper connection devices or fittings that depend on solder shall not be used.

S. Bond all metal conduits to the ground bus bar conductor of the control panel, terminal box, panelboard, switchboard, motor control center, disconnect safety switch or frame of the equipment to which they are connected by terminating each conduit with a threaded steel insulated grounding bushing or insulated throat, grounding type conduit hub having a solderless lug with a bonding jumper sized in accordance with NEC Table 250-66 attached to the ground bus conductor or equipment frame. Where the enclosure does not contain a ground bus bar, bond to the enclosure using a mechanical lug. Scrape away paint at grounding lug attachment location.

T. All control panel, panelboard, switchboard and motor control center ground bus conductors, power transformer cases, all transformer neutrals, and all rotating electrical equipment shall be solidly and directly grounded to the nearest approved grounding point, or as shown on the Drawings, using a conductor sized in accordance with the NEC Table 250-66 or as indicated on the Drawings.

U. Power system neutrals shall be grounded only at the transformer where each system neutral is derived in accordance with NEC Article 250.

V. Equipment grounds shall be made where indicated on the Drawings. Total resistance to ground shall not exceed five (5) ohms.

3.2 MOTOR GROUNDING

A. All motors rated 10 horsepower and below shall be grounded by an equipment grounding conductor, sized per the NEC, installed in the conduit with the power conductors that supply the motor.

B. All motors rated 11 to 74 horsepower shall be grounded with a bare, stranded No. 6 AWG grounding conductor in addition to an equipment grounding conductor sized per the NEC carried with the power conductors that supply the motor. The No. 6 grounding conductor shall be bonded to the motor frame. Mechanically attach the grounding conductor to the outside of the conduit carrying the power conductors that supply the motor.

3.3 RACEWAY SYSTEM GROUNDING

A. Ground/bond metallic conduits at all termination points.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all supports and fastening devices for mounting and anchoring all raceways and electrical equipment as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260533.13 – Conduit for Electrical Systems

C. Section 260533.16 – Boxes for Electrical Systems

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Expansion anchors
2. U-channel steel supports including associated hardware and accessories

PART 2 - PRODUCTS

2.1 GENERAL

A. *Weld Rod:* Use E70 electrodes for shielded metal arc welding.

B. Provide materials, sizes, and types of supports, anchors, and fasteners to carry the loads of conduit, boxes, and equipment. Include weight of wire and cable when selecting products for conduit, equipment and box supports.

2.2 ANCHORS AND FASTENERS

A. Provide anchors and fasteners as required to install all conduit, boxes, electrical enclosures, and equipment.

B. *Expansion Anchors:* Utilize expansion anchors for attachment of electrical equipment, boxes and raceways to concrete and solid masonry surfaces.

1. Expansion anchors shall be Type 304 stainless steel or galvanized steel, stud type expansion anchor with a single-piece, three-section wedge, Hilti Kwik Bolt III or approved equal installed per the manufacturer's written recommendations. The anchors shall meet the description in Federal Specification FF-S-325, Group II, Type 4, Class 1, for concrete expansion anchors. All bolts shall have length identification.

C. Provide adequate corrosion resistance for all fastening systems.

D. *Bolts and Nuts:* ANSI regular series, semi-finished, hexagon

1. Indoor dry areas: Cadmium plated steel
2. In water treatment and RO system areas: Type 304 stainless steel

E. *Flat Washers:*

1. Indoor dry areas: Cadmium plated steel
2. In water treatment and RO system areas: Type 304 stainless steel

F. *Lock Washers:* ANSI medium, spring type

1. Indoor dry areas: Cadmium plated steel
2. In water treatment and RO system areas: Type 304 stainless steel

G. *Beam Clamps:* Steel beam and angle clamps by B-Line or Thompson

1. Indoor dry areas: Cadmium, zinc plated or hot-dipped galvanized
2. In water treatment and RO system areas: Type 304 stainless steel

2.3 STRUCTURAL SUPPORT SYSTEMS

A. *Steel Supports:* Brackets, frames and hangers shall be fabricated from standard cold rolled structural steel shapes or prefabricated structural systems, as manufactured by B-Line Systems, Inc., Unistrut Corporation, Kindorf Electrical Products Co., or approved equal.

1. Steel supports and accessories used in indoor dry areas shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS Grade 33, then electro-plated with zinc per ASTM B633. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).
2. Steel supports and accessories used in water treatment and RO system areas shall be Type 304 stainless steel.
3. Steel supports shall be 14-gauge or 12-gauge and either 1-5/8" x 13/16" or 1-5/8" x 1-5/8" as required based on equipment to be supported.

B. *Hanger Supports:* Threaded rods

1. Indoor dry areas: Electro-galvanized steel
2. In water treatment and RO system areas: Type 304 stainless steel

PART 3 - EXECUTION

3.1 GENERAL

A. The methods of attaching or fastening equipment or equipment supports or hangers to the building structure shall be subject to the approval of the Construction Representative.

B. Do not drill or cut any structural steel members.

C. Do not cut any structural concrete members.

D. Welding on any structure shall require prior written approval from the Construction Representative for each type of application except where specifically shown on the Drawings. Weld in accordance with AWS.

E. Do not use piping, ductwork, raceways, or equipment as structural members for support.

F. Equipment or raceways shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions unless specifically indicated on the Drawings.

G. A minimum of four (4) anchor points shall be provided for electrical equipment enclosures and dimensioned boxes.

H. In water treatment and RO system areas, supports shall be installed to provide a minimum of 13/16" air space between wall mounted electrical equipment enclosures and mounting surface.

3.2 ANCHORS AND FASTENERS

A. Unless noted otherwise on the Drawings, expansion anchor embedment shall be as follows:

1.

Bolt Diameter, in.	Embedment, in.
1/4	2
3/8	2-1/2
1/2	3-1/2
5/8	4

B. Utilize welded fasteners or beam clamps for attachment of electrical equipment and raceways to structural steel surfaces in accordance with the requirements of the Designer or Construction Representative. Weld in accordance with AWS.

C. Utilize toggle bolts, hollow wall fasteners or through-wall bolt fasteners for attachment of electrical equipment, boxes and raceways to hollow masonry surfaces.

D. Utilize machine screws for attachment of electrical equipment, boxes, and raceways to metal surfaces.

E. Utilize wood screws for attachment of electrical equipment, boxes, and raceways to wood surfaces.

F. Nails shall not be used as a means of fastening.

G. Do not use spring steel clips.

H. Do not use powder-actuated anchors.

3.3 STRUCTURAL SUPPORT SYSTEMS

A. Weld in accordance with AWS.

B. Any galvanizing damaged by welding or erection shall be repaired with cold galvanizing per ASTM A780. Surface preparation shall include power disk sanding the abraded or welded area to bright metal.

C. Do not use chain.

D. Do not use perforated strap or wire.

3.4 SEISMIC BRACING

A. All electrical equipment shall be bolted down, and conduit shall be braced in accordance with the seismic design requirements of the International Building Code (latest adopted edition), utilizing the seismic loading factors noted on the Structural Drawings.

B. Conduit trapeze hangers shall be stabilized both horizontally and vertically to prevent swaying or movement.

C. Transverse and longitudinal braces shall be no more than 45° above or below the centerline of the conduit.

D. When bracing trapeze type hangers, the bracing shall be attached directly to the trapeze hanger assembly, and the conduit shall be secured to the trapeze assembly with conduit straps.

E. Seismic bracing shall not limit the expansion and contraction of the conduit system.

F. Contractor shall field locate bracing as required unless otherwise shown on the Drawings.

G. Seismic restraints may be omitted from the following installations:

1. All conduit suspended by individual hangers 12 inches or less in length from the top of the conduit to the bottom of the support for the hanger.

2. All electrical conduit less than 2-1/2 inches inside diameter

END OF SECTION 260529

SECTION 260533.13 – CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all raceways and fittings as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260533.16 – Boxes for Electrical Systems

F. Section 260553 – Identification for Electrical Systems

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Each type of conduit (galvanized rigid steel, rigid aluminum, liquidtight flexible metallic)
2. Conduit hubs
3. Conduit bodies
4. Conduit mounting clamps
5. Fire-stopping materials

PART 2 - PRODUCTS

2.1 CONDUIT

A. All conduit shall be new and shall be approved and listed by Underwriters' Laboratories, Inc. (UL) and shall bear the UL label of approval.

B. All conduit shall be one of the following:

1. Galvanized rigid steel conduit, “Heavywall” (GRC), shall be Schedule 40 steel conduit, hot dipped galvanized on both the outside and the inside. Conduit as obtained from the manufacturer shall have been cut and threaded before galvanizing, thereby insuring the galvanizing of these areas. Conduit shall

conform to the latest editions ANSI Standard C80.1 and UL Standard No. 6 and shall meet the requirements of NEC Article 344.

a. Minimum conduit size shall be 3/4-inch.

b. Running threads are not permitted.

c. GRC shall be used indoors in unfinished areas.

2. Rigid aluminum conduit (RAC), heavywall, copper-free threaded aluminum in accordance with ANSI C80.5 and shall meet the requirements of NEC Article 344.

a. Minimum conduit size shall be 1-1/2-inch.

b. Running threads are not permitted.

c. Rigid aluminum conduit may be substituted for GRC in sizes 1-1/2" and larger.

3. Liquidtight flexible metal conduit (LFMC) shall be square locked galvanized steel flexible tubing having an extruded liquidtight thermoplastic or polyvinyl chloride (PVC) jacket, making the conduit moisture proof, oil proof, and sunlight resistant LFMC shall conform to U.L. Standard 360 and shall meet the requirements of NEC Article 350. Liquidtight flexible metal conduit shall be used at all locations where a flexible conduit connection is required.

a. Minimum conduit size shall be 1/2-inch.

b. Conduit and fittings shall be rated for 90°C conductors or cable and for use in direct sunlight.

c. Liquidtight flexible metal conduit shall contain a continuous copper ground built into the core in sizes 1/2-inch through 1-1/4-inch, and all sizes shall be approved and listed by Underwriters' Laboratories, Inc. (UL). Liquidtight flexible metal conduit shall be rated for a minimum temperature range of -20°C (-4°F) to +60°C (+140°F), and shall be as manufactured by the following:

1) Anamet, Inc., Type UA

2) Electri-Flex Company, Type LA Liquatite

3) Southwire/Alflex, Type UL Ultratite

d. All connectors and couplings for liquidtight flexible metal conduit shall be malleable iron with hot-dipped galvanized or steel with zinc plated finish, compression ring, positive ground, positive grip, liquid tight, rain-tight and oil tight.

e. All connectors and fittings shall be UL Listed as suitable for grounding in sizes 1/2-inch through 1-1/4-inch.

f. All connectors shall be insulated throat type. All connectors shall be terminated with a bonding type locknut. Threaded steel insulated grounding bushings having solderless lugs shall be used where required.

g. All connectors in sizes 1-1/2-inch and larger shall have a grounding lug on the gland nut for connection of an external grounding conductor in accordance with Section 260526 - Grounding and Bonding for Electrical Systems.

h. Neither flexible metal conduit ("greenfield") nor liquidtight flexible nonmetallic conduit shall be substituted for liquidtight flexible metal conduit.

i. Unless otherwise indicated, liquidtight flexible metal conduit shall only be used for the final connection to:

1) Vibrating type equipment, such as motors and transformers (flexible connection not to exceed 3 feet)

2) All remotely located control devices and instrumentation such as level switches, solenoid valves, position switches, limit switches, level transmitters, etc. (flexible connection not to exceed 2 feet)

3) As permitted elsewhere in these Specifications or Drawings

2.2 CONDUIT HUBS

A. Conduit hubs shall be insulated throat, liquid-tight "copper-free" aluminum for aluminum conduit and stainless steel enclosures and zinc plated steel or malleable iron for rigid galvanized steel conduit and galvanized steel and painted steel enclosures, grounding type with ground lug/screw on the lock nut.

B. Conduit hubs shall be Myers Type STAG or STG Scru-Tite or approved equal.

2.3 CONDUIT BODIES

A. Conduit bodies shall be provided as required or where indicated on the Drawings and shall be hot-dipped galvanized malleable iron with galvanized steel gasketed covers or cast, "copper-free" aluminum having threaded hubs and stainless steel or "copper-free" aluminum, neoprene gasketed covers fastened with stainless steel screws, rain-tight, suitable for wet locations, Crouse-Hinds, Appleton or O-Z Gedney Form 35, Form 8, Mark 9, or Mogul. Die-cast aluminum types are not acceptable.

B. Conduit body cover screws shall thread directly into the conduit body. Conduit body covers with wedge-clamp type covers are not acceptable.

C. Conduit body hub configuration shall be as required based on conduit routing for the cover to be readily accessible for easy removal.

D. Conduit bodies enclosing size 6 AWG or smaller conductors shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit to which the conduit body is attached.

E. Only those conduit bodies that are durably and legibly marked by the manufacturer with their cubic inch capacity shall be permitted to contain splices, taps, or devices. The maximum number of conductors shall be computed in accordance with NEC Article 314-16(C).

2.4 CONDUIT MOUNTING CLAMPS

A. Conduit mounting clamps for securing conduits inside buildings shall be one-hole, two-hole or H-Type (mini's); galvanized steel in indoor dry areas and Type 304 stainless steel in water treatment and RO system areas.

B. Conduit mounting clamps for securing rigid metal conduits to concrete or masonry surfaces inside buildings in dry areas shall be one piece "copper-free" aluminum or zinc plated malleable iron one hole type, Crouse-Hinds Cat. No. 5XX or approved equal with Crouse-Hinds Cat. No. CBX or approved equal "copper-free" aluminum or zinc plated malleable iron clamp backs/spacers.

C. Conduit mounting clamps for mounting conduits to channel supports shall be zinc plated steel, hot-dipped galvanized steel or Type 304 stainless steel to match channel support material, B-Line B2000 Series or approved equal.

2.5 FIRE-STOPPING MATERIALS

A. The following fire-resistant penetration sealing materials are approved:

1. 3M Caulk CP 25
2. 3M Wrap/Strip FS-195
3. Damming materials – 3M Composite Sheet CS-195
4. SpecSeal Series 100 sealant
5. Rector Seal Corporation, Metacaulk 835 fire stopping sealant
6. Dow Corning 3-6548 silicone RTV foam
7. General Electric GE RTV850 or GE RTV6428
8. Chase Technology Corporation CTC PR-855 fire-resistant silicone foam

2.6 CONDUIT PULL STRING

A. Conduit pull string shall be Greenlee or equal with a minimum of 240 lbs. tensile strength, and shall be rot and mildew resistant. Pull string shall have permanently printed sequential measurements at one-foot increments.

PART 3 - EXECUTION

3.1 INSTALLATION

A. CONDUIT

1. Verify routing and termination locations of conduit runs prior to rough-in.
2. Conduit routing shown on Drawings is approximate. Route as required to complete wiring.
3. Design, layout, and detail conduit runs to permit installation.
4. Coordinate conduit routing with the Construction Representative to avoid equipment operational and maintenance interferences and to permit easy removal of all conduit body and box covers.
5. Conduit or fittings having any type of defects shall not be used in the work.
6. Exposed conduit shall be run perpendicular or parallel to building walls. Where more than one conduit in a bank of exposed conduit changes direction, all bends shall be concentric.
7. The Contractor shall consult all of the other trade drawings to ascertain where conflicts may occur and shall install all conduit as required to avoid conflicts.
8. Conduits shall be continuous from outlet to outlet, from outlet to junction or pull boxes, from source panel to equipment, and shall be terminated to all boxes and enclosures in such a manner that the conduit system is mechanically and electrically continuous throughout the system.

9. The Contractor shall furnish and install NEC sized pull boxes or conduit bodies wherever necessary in order that a run of conduit between conductor/cable pulling points does not contain more than the equivalent of four quarter (90 degree) bends (360 degrees total).

10. Conduit bends shall not be less than the standard radius, unless otherwise indicated.

11. A minimum clearance of nine inches (9") shall be maintained between all conduits and pipes carrying steam, hot liquids, or hot gases, except at points of cross over, in which case the clearance may be reduced to six inches (6"). Any exceptions to this shall be presented to the Designer for approval on an individual case by case basis.

12. Maintain adequate clearance between conduit and piping, allowing for the maintenance of insulation and outer protective covering on piping.

13. Couplings for conduits in a group shall be staggered at least six (6) inches.

14. Conduit shall not be routed along floors.

15. Conduits shall be concealed in finished spaces and exposed in unfinished spaces.

16. In unfinished spaces, arrange conduit to maintain minimum 7'-6" headroom above floors, unless otherwise approved by the Construction Representative.

17. All rigid metal conduit, threaded joints and couplings shall be made up wrench tight with at least five full threads engaged. The use of running threads at conduit couplings and terminations is prohibited. All cut ends of conduits shall be reamed to remove rough edges and shall be free of burrs and sharp edges. An approved aluminum lubricant shall be used with rigid aluminum conduit.

18. Coat all field cut threads, scars, or wrench abrasions in rigid galvanized steel conduit with an approved organic zinc rich primer equivalent to Koppers' "Organic Zinc."

19. Conduit shall be supported on approved types of steel brackets, channels, ceiling trapeze, pipe straps or hangers secured by means of toggle bolts, hollow wall fasteners or through wall bolt fasteners on hollow masonry or clay tile blocks; or expansion anchors in concrete or brick; or machine screws on metal surfaces; or wood screws on wood construction. Nails or powder-actuated anchors shall not be used as a means of fastening. Perforated flat steel straps or wire shall not be used for supporting conduit. All conduit shall be properly supported in accordance with Section 260529 – Hangers and Supports for Electrical Equipment in order to deter any possible vibration, noise or chatter.

20. Conduit shall be supported from building structures. Do not use piping, ductwork, other raceways or equipment for supporting conduits. Support all conduit runs at a minimum of every 10 feet and within 3 feet of all terminations.

21. Where possible, group conduits on U-channel conduit racks.

22. Utilize U-channel supports and associated fittings and hardware for conduit support in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.

23. Terminate rigid metal conduits at all NEMA Type 1 junction and pull boxes and equipment enclosures inside buildings with a minimum of two (2) locknuts, one inside and one outside the enclosure, and a steel or malleable iron insulated throat, grounding bushing having a solderless lug and a copper bonding jumper, sized in

accordance with NEC Article 250, to connect the conduit to the equipment grounding bus bar located inside the enclosure. Provide a grounding lug where the enclosure does not contain an equipment grounding bus bar.

24. Provide insulated throat, liquid tight, grounding type conduit hubs to terminate rigid metal conduits at all NEMA Type 3, 3R, 4, 4X, 12 and 13 enclosures without integral cast threaded hubs. Provide a copper bonding jumper, sized in accordance with NEC Article 250, to connect the conduit hub locknut to the equipment grounding bus bar located inside the enclosure. Provide a grounding lug where the enclosure does not contain an equipment grounding bus bar.

25. Grounding and bonding of conduit shall be in accordance with Section 260526 – Grounding and Bonding for Electrical Systems.

26. Identify all conduit runs; both new conduit and existing that is reused, in accordance with Section 260553 – Identification for Electrical Systems.

27. Prior to installing any cables in any existing conduit that is to be reused, demonstrate to the Construction Representative that the conduit is clear of obstructions by pulling a mandrel 1/2-inch smaller than the nominal size of the conduit through the entire length of the conduit.

B. CONDUIT BODIES

1. Conduit bodies shall be sized for the conductor fill of the conduits to which it is connected. Use Mogul type conduit bodies if/as required.

2. Conduit body sizing shall be based on the maximum number of conductors permitted accordance with NEC Article 314-16(C).

3. Conduit bodies enclosing size 6 AWG or smaller conductors shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit to which the conduit body is attached.

4. Conduit bodies are not permitted to contain splices, taps, or devices.

5. Conduit bodies shall be supported in a rigid and secure manner.

C. CONDUIT MOUNTING CLAMPS

1. Conduit shall not be mounted in direct contact with any concrete or masonry wall or ceiling. Utilize U-channel supports or clamp backs/spacers to hold conduits a minimum of 3/16 inch away from concrete or masonry surfaces. Clamp backs/spacers shall be stackable to allow the conduit to be spaced further away from the mounting surface as required.

D. CONDUIT OPENINGS

1. Provide conduit openings in floors and walls as required to install conduit runs. Openings shall be kept to a minimum, as small as possible, and installed in a neat manner. All damage to existing surrounding surfaces when installing openings shall be repaired to original condition.

2. Locations of all openings shall be approved by the Construction Representative before beginning work.

3. Core drill all openings in existing concrete or masonry surfaces using a dustless method.

4. After installation of conduit, openings in concrete or masonry shall be formed, grouted, and caulked to provide a moisture and fire barrier that is equivalent to the fire rating of the wall or floor.

5. All openings through which a conduit passes in walls and floors shall be properly sealed after the conduit is installed to prevent transmission or leakage of liquids, dust, fire, smoke, or sound. Openings in non-fire rated concrete or masonry construction through which conduit passes shall be sealed, after the conduit is installed, with material similar to that which surrounds the opening. Openings in fire-rated construction through which conduit passes shall be sealed, after the conduit is installed, with an APPROVED fire-resistant penetration seal. All fire-resistant penetration seals shall be installed in accordance with the manufacturer's instructions.

END OF SECTION 260533.13

SECTION 260533.16 – BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all electrical boxes as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260533.13 – Conduit for Electrical Systems

F. Section 260553 – Identification for Electrical Systems

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Outlet and non-dimensioned junction and pull boxes and device boxes
2. Dimensioned junction and pull boxes

PART 2 - PRODUCTS

2.1 GENERAL

A. All electrical boxes, including extension rings, plaster rings, covers and other accessories, shall be UL Listed and Labeled.

B. All outlet, device and nondimensioned junction and pull boxes shall be sized in accordance with the allowable wiring fill permitted by the National Electrical Code (NEC).

C. Junction boxes and pull boxes shall be sized as per the NEC or as shown on the Drawings.

D. Outlet boxes shall be of the size and type to accommodate the structural conditions, the size and number of raceways, conductors or cables entering, and the wiring device with which the box is intended to be used. Install blank plates on all outlet boxes where apparatus is installed which does not, in itself, provide a cover for the box.

E. Unless otherwise indicated, all junction or pull box covers shall be fastened with cadmium plated or galvanized steel screws or bolts for indoor applications and stainless-steel screws or bolts for outdoor applications. The removable cover shall be fabricated from the same material as the box, and the cover shall be on the largest accessible side of the box unless otherwise indicated. The cover of the box shall be designed for quick removal.

F. Boxes shall be as manufactured by Appleton Electric Company, Eaton Crouse-Hinds, Steel City, Raco, Killark Electric Manufacturing Company, O-Z/Gedney Company, Hoffman Engineering Company, Wiegmann or approved equal.

2.2 BOXES FOR NONHAZARDOUS AREAS

A. Nondimensioned junction and pull boxes and device boxes located in indoor dry areas shall be hot-dipped galvanized drawn steel, 4-inch square, 4-11/16-inch square or octagon, 1-1/2 inch minimum depth, NEMA Type 1 with plaster ring, if/as required. Sectional boxes are not acceptable.

B. Nondimensioned junction and pull boxes and device boxes located in water treatment and RO system areas shall be cast, cadmium or zinc plated malleable iron or "copper-free" aluminum, having threaded hubs and neoprene gasketed covers fastened with four (4) stainless steel screws, NEMA Type 4, Crouse-Hinds Type GRFX, or GS, or approved equal, or Crouse-Hinds, Appleton Electric or Killark 2-1/8 inch deep Type FD, or approved equal.

C. Dimensioned junction and pull boxes located in indoor dry areas shall be painted steel, galvanized steel or code gauge sheet aluminum, NEMA Type 12 having removable neoprene gasketed covers fastened with cadmium plated or galvanized steel screws, and continuously welded seams (ground smooth) with no holes or knockouts

D. Dimensioned junction and pull boxes located in water treatment and RO system areas shall be painted steel, galvanized steel or code gauge sheet aluminum, NEMA Type 4 having removable neoprene gasketed covers fastened with cadmium plated or galvanized steel screws, and continuously welded seams (ground smooth) with no holes or knockouts.

E. Pull and junction boxes shall be sized in accordance with NEC Article 314-16 or 314-28 as a minimum. Larger boxes may be provided.

F. Provide hinged cover enclosures for any box larger than 12 inches in any dimension.

G. Provide grounded metallic barriers in dimensioned junction and pull boxes as required to isolate power circuits from other types of circuits. Barriers shall be designed so as not to separate the phases of a power circuit. Barriers shall be constructed of the same material as the box in which they are installed.

H. Inner Back Panels: Provide white painted steel, galvanized steel, or code gauge sheet aluminum inner back panel, to match box construction, inside all boxes in which terminal blocks or control devices are located.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Boxes, General

1. Locate and install boxes to allow access. Coordinate with other trades to ensure boxes are not made inaccessible by equipment, duct work or piping installation.

2. Locate and install to maintain headroom and to present a neat appearance.

3. Special care shall be taken to set all boxes square and true with the building finish. As far as possible, all boxes shall be secured to the building structure or steel, using adjustable supports where necessary.

4. Outlet boxes in unfinished areas shall be surface (exposed) mounted to columns or walls, unless otherwise indicated.

5. Final correct readjustment shall be made to outlet boxes, if necessary, to give proper centering. In centering and location of outlet boxes, allowance shall be made for overhead pipes, ducts, and other mechanical equipment and for variation in the arrangement and thickness of walls, fireproofing, etc. Any inaccuracy resulting from failure to take the above into consideration shall be corrected by the Contractor without additional expense to the Owner.

6. Boxes located in damp or wet locations shall have stainless steel or other Designer approved corrosion resistant spacers installed to provide a minimum of 1/4-inch air space between the back of the box and the mounting surface.

7. All boxes shall be rigidly mounted.

8. Securely fasten boxes to building structure, independent of the conduit, except for splice boxes that are connected to two metal conduits, both supported within 12 inches of the box.

9. All conduits entering sheet metal junction or pull boxes shall be through holes properly cut with a punch and die. Cast boxes shall be provided with threaded conduit bosses or hubs of proper size and externally located cast feet for mounting.

10. All open conduit knockouts, holes or hubs in electrical enclosures that are not used shall be properly plugged with suitable blanking devices of the same material as the box that maintain the NEMA rating of the box. Utilize stainless steel blanking devices for stainless steel boxes. Utilize NEMA 12 rated hole seals devices to seal all open holes in the top of all panelboards, switchboards, motor control centers and in NEMA 12 rated dimensioned junction and pull boxes. Provide NEMA 4 rated hole seals for NEMA 4 rated junction and pull boxes and electrical enclosures.

11. Junction and pull boxes shall be furnished and installed where indicated on the Drawings, required by code, and wherever else such a box may be deemed necessary to facilitate the pulling or splicing of wires or cables. In general, junction or pull boxes shall be installed to limit conduit runs to 125 feet and conduit bends to a maximum total of 360 degrees. The Contractor shall furnish and install properly sized pull boxes wherever necessary in order that a run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter (90 degree) bends (360 degrees total). Additional pull boxes may be needed to facilitate wire pulling. All boxes shall be installed in locations that will be accessible after completion of the construction.

12. Dimensioned pull and junction boxes shall be sized in accordance with NEC Article 314-28 unless a larger size box is indicated on the Drawings.

13. Location of junction and pull boxes shall be approved before installation. Where necessary, conduits may be rerouted with the approval of the Construction Representative.

14. Rigid metal conduits terminating in all NEMA Type 3, 3R, 4, 4X, 12 or 13 boxes and enclosures, without integral cast threaded hubs shall be terminated in insulated throat, grounding type, liquid tight, rigid conduit hubs. Conduit hubs shall be provided in accordance with Section 260533.13 – Conduit for Electrical Systems.

15. Provide a grounding type conduit bushing with solderless lug and copper bonding jumper sized in accordance with NEC Article 250 for all conduits terminating in NEMA Type 1 boxes and enclosures in accordance with Section 260526 – Grounding and Bonding for Electrical Systems.

16. All junction boxes, pull boxes, and wire troughs with a hinged cover shall be installed such that the cover can be opened at least 90˚.

17. Junction and pull boxes with a hinged cover that are located on a wall shall be mounted such that the cover opens to the right or to the left but not up or down.

3.2 CIRCUIT IDENTIFICATION

A. Junction, pull, outlet, and device boxes shall be identified in accordance with the requirements of Section 260553 – Identification for Electrical Systems.

B. Cover plates for all junction and pull boxes shall be marked on the inside surface of the cover plate in finished areas or on the outside surface of the cover in unfinished areas in accordance with Section 260553 – Identification for Electrical Systems.

C. All conductors in a junction or pull box shall be identified in accordance with Section 260553 – Identification for Electrical Systems.

END OF SECTION 260533.16

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install electrical identification for electrical equipment, conductors, cables, and boxes as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 230515 – Variable-Frequency Motor Controllers

B. Section 260500 – Common Work Results for Electrical

C. Section 260519 – Low-Voltage Electrical Power Conductors & Cables

D. Section 260533.13 – Conduit for Electrical Systems

E. Section 260533.16 – Boxes for Electrical Systems

F. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

G. Section 262816.16 – Enclosed Switches

1.4 SUBMITTALS

A. Submit electrical identification data as follows:

1. Nameplate type product data
2. Nameplate engraving schedule
3. Wire and cable identification label product data
4. Conduit marker product data
5. Arc flash hazard warning labels

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Nameplates shall be three-layer laminated plastic with engraved black characters on a white background for normal utility power circuits and equipment and engraved white characters on a red background for emergency generator circuits and equipment or as indicated otherwise on the Drawings.

B. Nameplates that will be located outdoors must be constructed from material that is waterproof and UV resistant.

C. Nameplate engraving shall be as follows:

1. Lettering font shall be Gothic.

2. Nameplate character sizes shall be:

a. 3/8-inch high – Motor control center starter and feeder units, control panels, variable-frequency motor controllers, enclosed switches, terminal boxes, dimensioned junction boxes and dimensioned pull boxes.

b. 1/4-inch high – Motor terminal boxes

c. 1/8-inch high – Local control stations

3. Lettering shall be centered on nameplate.

4. Nameplates shall have a maximum of forty (40) characters per line with a maximum of four (4) lines.

5. Wording on nameplate shall include the equipment designation as indicated on the Drawings.

6. In addition, the engraved nameplate for each variable-frequency motor controller and motor disconnect switch shall also indicate the source panel it is served from and the service voltage and number of phases/wires such as: "480V-3PH-3W, GRD B-PH" or "208Y/120V-3PH-4W".

7. Each variable frequency motor controller, motor starter and fusible switch on the 480V, 3-phase delta, grounded B-Phase power system shall also have an engraved nameplate that indicates the fuse size and type such as:

REPLACEMENT FUSES:
UL CLASS RK1 XXA – PHASE A & C
SOLID NEUTRAL LINK – PHASE B

8. Engraving designations shall be approved by the Designer.

D. Special nameplates shall be as indicated on the Drawings.

2.2 CONDUIT MARKERS

A. Conduit markers shall be vinyl "peel and stick" type with black characters on an orange background:

1. Conduits 1-1/4" and smaller.....1/2" characters

2. Conduits 1-1/2" and larger .....1" characters

B. Markers shall identify voltage and functional use of the conduit, such as "480 VOLT - 3 PHASE", "120 VOLT", "CONTROL", "INSTRUMENTATION", etc.

2.3 WIRE LABELS AND CABLE MARKERS

A. Wire labels for No. 4/0 AWG and smaller wires shall be vinyl film, self-laminating, adhesive wraparound type; W. H. Brady Co. B-292, Thomas & Betts WSL Series or approved equal.

B. Cable markers for cables and wire labels for all conductors 250 KCM and larger shall be polyester film, non-adhesive, plate type designed for cable tie banding parallel to the cable/conductor.

C. Wire and cable identification numbers shall be printer generated or typewritten on the labels and markers.

D. Character size for cable identification numbers shall be a minimum of 1/8-inch high.

E. Markers labels, number generation method, and attachment methods shall be subject to the approval of the Engineer.

2.4 ARC FLASH HAZARD WARNING LABELS

A. Warning labels for electrical equipment shall be color printed, waterproof, approved by the Designer and furnished and installed by the Contractor.

B. For incident energy values less than or equal to 40 cal/cm^2, label shall indicate "WARNING" using black lettering on an orange background.

C. For incident energy values greater than 40 cal/cm^2, label shall indicate "DANGER" using white lettering on a red background.

D. At a minimum, each label shall include the following:

1. Equipment location
2. Source protective device name providing the protection (fed from)
3. Nominal system voltage
4. Arc flash boundary
5. Specific arc incident energy available
6. Bolted fault current available
7. Label date

NOTE: Print appropriate information on label based on the arc flash risk assessment report provided in accordance with Specification Section 260573 – Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment.

E. Size of warning labels shall be:

1. Equipment main bus rating less than 400A: 3.5" x 5"
2. Equipment main bus rating 400A or more: 5" x 7"

2.5 COLOR CODE TAPE

A. Each conductor, except control and signal conductors, shall be color coded with 3M No. 35 tape, 3/4" width, or colored insulation.

1. Color coding for 600-volt conductors shall be:

120/240V 1 Phase	120/208V 3 Phase	480V 3 Phase, GRD B-PH
Phase A Black	Phase A Black	Phase A Brown
Phase B Red	Phase B Red	Phase B White or Gray
Neutral White	Phase C Blue	Phase C Yellow
Equipment Ground Green	Neutral White	Equipment Ground Green
	Equipment Ground Green	

B. Wiring to contacts powered from an external source shall be yellow.

C. Conductors for direct current (DC) circuits shall be color coded red for positive (+) conductor and black for negative (-) conductor.

2.6 PANELBOARD CIRCUIT DIRECTORIES

A. Each panelboard shall have a framed circuit directory card with a clear plastic covering mounted on the inside of the door.

B. The directory card shall provide a space at least 1/4-inch high by 3 inches long, or the equivalent, for each circuit.

C. The directory card shall be typed to identify the load fed by each circuit for compliance with NEC 408.4.

PART 3 - EXECUTION

3.1 GENERAL

A. Degrease and clean surfaces to receive nameplates, markers, labels, and color code tape.

3.2 NAMEPLATES

A. Nameplates shall be provided for each switchgear circuit breaker, panelboard, control panel, terminal box, dimensioned pull box, dimensioned junction box, and local control station.

B. Nameplates shall be secured with an approved adhesive such as Goodyear "Pliobond" glue or stainless-steel machine screws in tapped holes. Self-tapping screws or sheet metal screws shall not be used.

3.3 CONDUIT MARKERS

A. Attach a conduit identification marker to each conduit at all termination points and at 20' intervals along the entire length of the conduit.

B. Secure markers parallel to conduit in a readily visible location.

3.4 WIRE LABELS AND CABLE MARKERS

A. Branch circuits, control and signal wires and cables shall be identified.

1. Attach a wire identification label to each conductor of a circuit cable group at each termination point.

2. Attach a cable identification marker to each circuit cable group at all termination entry points.

B. Wire labels and cable markers shall identify each conductor and cable with the circuit number. Identify with branch circuit or feeder number for power circuits and with control wire or cable number as indicated on schematic and interconnection diagrams and equipment shop drawings for control wiring.

C. Cable markers for cables and wire labels for all conductors 250 KCM and larger shall be secured with heavy duty plastic cable ties. Cut excess tie material off flush with tie clasp. Do not leave sharp edges.

3.5 ARC FLASH HAZARD WARNING LABELS

A. Provide arc flash hazard warning labels in accordance with NEC Article 110-16 for the following equipment:

1. New variable-frequency motor controllers and motor disconnect switches
2. Existing switchboards, panelboards, motor control centers, low-voltage distribution transformers, motor starters and disconnect switches where circuits have been added or removed or where the main feeder is being replaced.
3. All switchboards, panelboards, low-voltage distribution transformers, and motor control centers in the series electrical path from the electrical equipment specified herein as needing a label up to the main 480V switchboard serving the north portion of the Power Plant.

B. Labels shall be applied to the outside of the front cover at the center of the cover such that the label is clearly visible with the door closed.

C. Switchgear, switchboards, panelboards, and motor control centers having multiple sections shall have one 5" x 7" label applied to each section.

D. Clean the surface to which each label is to be applied with isopropyl alcohol or a similar, fast evaporating cleaning agent that will not damage the paint finish.

3.6 COLOR CODE TAPE

A. Code all wire and cable not available color coded from manufacturer by application of electrical plastic tape in colors specified. Apply tape in uniform manner circling wire or cable. Half-lap tape for length of cable as required by Local Authorities or NEC but not less than five (5) full wraps.

3.7 JUNCTION, PULL, OUTLET AND DEVICE BOX IDENTIFICATION

A. Cover plates for all non-dimensioned junction and pull boxes shall be marked on the outside surface of the cover plate with the voltage, panel and circuit number of the branch circuit(s) contained inside the box. Marking shall be with printer generated "peel and stick" labels.

B. Nameplates shall be provided on the external surface of the cover of all dimensioned junction and pull boxes which shall identify the source voltage of the circuits inside the box as well as the location of the AC power source(s) for these circuits.

3.8 PANELBOARD CIRCUIT DIRECTORIES

A. Provide new "updated" directory cards for existing panelboards in which circuits have been rearranged, added, or deleted.

B. The directory card shall be typewritten or printer generated to identify the load served by each circuit.

C. Trace out unidentified circuits in existing panels and indicate load served on new circuit directory for compliance with NEC 408.4.

END OF SECTION 260553

SECTION 260573 – PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH RISK ASSESSMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. This Section includes computer-based fault-current, overcurrent protective device coordination and arc flash risk assessment studies, and the setting of these devices and application of proper arc flash hazard warning labeling to equipment.

1. Coordination Study Report shall include: Short circuit analysis, time current characteristics for all protective devices, graphical demonstration of selectivity, relay and overcurrent protection device instruction books, and pertinent manufacturer data, and Missouri registered Professional Engineer seal and signature.
2. Arc flash risk assessment report, with Missouri registered Professional Engineer seal and signature.
3. Series ratings of protective devices are not acceptable unless specifically authorized by the Engineer for existing equipment. These situations will be addressed on a case-by-case basis.

1.3 RELATED SECTIONS

A. Section 230515 – Variable-Frequency Motor Controllers

B. Section 232519.16 – Reverse Osmosis Water Treatment Equipment

C. Section 232519.20 – Reverse Osmosis Water Treatment Equipment System Controls

D. Section 232519.40 – Reverse Osmosis Water Pumping System

E. Section 260500 – Common Work Results for Electrical

F. Section 260553 – Identification for Electrical Systems

G. Section 262813 – Fuses

H. Section 262816.16 – Enclosed Switches

1.4 SUBMITTALS

A. Study documentation

1. Product Certificates: For coordination study and fault-current study computer software programs, certifying compliance with IEEE 399
2. Qualification Data: For fault-current study and arc flash risk assessment specialist who shall be a professional engineer registered in the State of the Missouri

3. Demonstrate experience with Arc Flash Risk Assessment by submitting names of at least three actual Arc Flash Risk Assessments performed in the past year.

4. Demonstrate capabilities in providing equipment, services, and training to reduce Arc Flash exposure.

5. Demonstrate experience in providing equipment labels in compliance with NFPA 70 (2020 edition), Article 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

6. Single-line diagram

   a. Include as installed cable/conductor lengths, size and number of conductors for each circuit segment.

7. Fault-current study report

8. Coordination study report including completed computer program input data sheets

9. Equipment evaluation report

10. Overcurrent protective device settings report

11. Arc flash risk assessment report

B. Submit an electronic copy of the fault-current, overcurrent protective device coordination, and arc flash risk assessment studies for review and comment prior to or along with all submittals related to new overcurrent protective devices to be furnished on this project; medium-voltage vacuum circuit breakers, low-voltage circuit breakers, fuses, etc.

C. Final report

1. Provide two (2) bound copies of the approved fault-current, overcurrent protective device coordination, and arc flash risk assessment studies bound in 8-1/2 inch by 11-inch volumes with drawings and diagrams folded to fit the 8-1/2 inch by 11-inch format, sealed and signed by licensed Missouri Professional Engineer. Report cover shall be extra heavy weight paper (80 lb or heavier). Report data shall be printed on 8-1/2 inch by 11-inch paper. Diagrams, drawings, and coordination curves shall be printed on 11 inch by 17-inch paper unless larger size drawings, 36” x 42” maximum size, are required for legibility. Securely retain larger size drawings by folding and placing in pockets bound into report.

2. Provide one complete copy of all report documentation on CD to include all data files, drawings, and diagrams. File types for the report documentation should be .doc, .pdf, .dwg, or .xls. In addition, provide complete study files, in the native SKM software format, on CD to include all models, data, single lines, etc.

D. General report requirements:

1. Include all facility power distribution system equipment located at the Potosi Correctional Center Power Plant shown on Drawing E-601.

2. Provide identification and description of industry testing standards on which study is based, for each section of study.

3. Provide calculations, impedance diagrams, conclusions, and recommendations as part of study general content.

4. Provide short circuit tabulations which include system impedances, X/R ratio, asymmetry factor, kVA, and symmetrical and asymmetrical fault currents.

5. Provide each study with following:

   a. Coordination plots which graphically indicate coordination proposed for several systems. Provide plots centered on full scale log-log-forms.

   b. Coordination plots with complete titles, representative one-line diagrams and legends, associated power company's system characteristics, significant motor starting characteristics, complete parameters for power, fuses, if applicable, and associated system load protective devices.

   c. Coordination plots which define types of protective devices selected, with proposed coil taps, time dial settings, and pick-up settings required.

   d. Long time region of coordination plots shall indicate complete tap scale for each relay and full load current transformer parameters and designate pick-ups required for low voltage circuit breakers.

   e. Short time region shall indicate low voltage circuit breaker, short time and instantaneous trip devices, fuse manufacturing tolerance bands, when applicable, and significant symmetrical and asymmetrical fault currents.

6. Coordinate each item of equipment as follows:

   a. Separate low voltage power circuit breakers from each other by 16 percent current margin for coordination and protection in event of secondary line-to-line faults.

   b. Terminate protective device characteristics or operating band to reflect actual symmetrical and asymmetrical fault currents sensed by device.

   c. Prepare study with network analyzer, computer, or by written calculations. Include complete fault calculations as specified for each proposed and ultimate source combination.

   d. Source combinations include proposed and future large motors or generators.

E. Drawings and specifications indicate general requirements for motors, motor starter equipment, and low voltage equipment. Determine additional specific characteristics of equipment furnished in accordance with results of short circuit and protective device coordination study.

1. Short circuit protective device coordination and arc flash study shall be coordinated with Contractor provided equipment shop drawings and existing conditions.

2. Submit equipment design discrepancies and proposed corrective modifications, if required, with short circuit and protective device coordination study. Identify variations clearly on shop drawings.

3. Provide equipment, overcurrent devices, field settings, adjustments, and minor modifications for conformance with approved short circuit and protective device coordination study.

4. Identify existing equipment that is overstressed with recommended solution, including series rating of the equipment if that is possible.

1.5 APPLICABLE STANDARDS

A. ANSI/IEEE C37.46 – Power Fuses and Fuse Disconnecting

B. ANSI Z535.4 – Product Safety Signs and Labels, Includes Errata

C. ICEA P-32-382 – Short Circuit Characteristics of Insulated Cable

D. ICEA P-45-482 – Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables

E. IEEE 141 – IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)

F. IEEE 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)

G. IEEE 399 – IEEE Recommended Practice for Power Systems Analysis (IEEE Brown Book).

H. IEEE 1015 – IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems (IEEE Emerald Book).

I. IEEE 1584 – IEEE Guide for Performing Arc Flash Calculations

J. NFPA 70 – National Electrical Code

K. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

L. NFPA 70E – Standard for Electrical Safety in the Workplace

M. International Electrical Testing Association, Inc. (NETA) – Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

1.6 QUALITY ASSURANCE

A. Studies shall use licensed computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for electrical short circuit analysis and coordination studies having performed successful studies of similar magnitude on electrical distribution systems using similar devices. The coordination study shall be performed by a project state registered professional electrical engineer, in accordance with ANSI/IEEE Standard 242, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems."

C. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise testing specified herein.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

1.7 ACCEPTABLE STUDY PROVIDERS

A. Protective Device Coordination Study and Arc Flash Risk Assessment Report Provider:

1. ABB-GE Engineering Services
2. BHMG Engineers, Inc. (Corey Jasper, P.E. – 314-686-1216)
3. Eaton Electrical Services & Systems (Mark Freyenberger, P.E. – 314-856-2645)
4. Schneider Electric Engineering Services, LLC

1.8 COMPUTER SOFTWARE PROGRAM

A. Computer Software Program: Subject to compliance with requirements, the protective device coordination study and arc flash risk assessment shall be provided using SKM Power Tools Electrical Engineering Software (PTW 32) by SKM Systems Analysis, Inc., ESA, Inc., or CYME International, Inc.

1.9 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Computer software program must comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory", "very desirable", and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall provide plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Additional Program Features:
    a. Arcing faults
    b. Simultaneous faults
    c. Explicit negative sequence
    d. Mutual coupling in zero sequence
    e. Arc flash risk assessment

1.10 EXAMINATION

A. Examine protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated shall be as indicated on the one-line diagrams on the Drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Protective devices not submitted for approval with coordination study may not be used in study. Protective devices submitted prior to this coordination study will be reviewed, but final approval will be contingent upon the study results.

C. Field verify all information shown on the electrical one-line diagrams, including but not limited to:

1. Ratings of existing equipment
2. Transformer ratings and impedances
3. Overcurrent protective device sizes/ratings
4. Conductor types and sizes
5. Conduit types (magnetic or non-magnetic)

6. Feeder lengths

D. Update project one-line diagrams with information obtained from field verifications

1.11 FAULT-CURRENT STUDY

A. Fault study shall incorporate the available utility fault current information provided by:

Ameren Missouri Construction Services
866-992-6619
servicerequest@ameren.com

B. Study electrical distribution system for all Ameren Missouri sources and all Ameren source switching scenarios as well as for the alternate source (power plant emergency diesel-engine-driven generator) using an approved computer software program to calculate values in order to determine the maximum fault conditions.

C. Calculate momentary and interrupting duties based on the maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50
2. Low-Voltage Fuses: IEEE C37.46
3. Circuit Breakers: IEEE C37.13

E. Fault study must be completed and submitted prior to proceeding with procurement/manufacturing of any of the following equipment:

1. RO water treatment booster pump VFD specified under Section 260515 – Variable-Frequency Motor Controllers and Section 232519.16 – Reverse Osmosis Water Treatment Equipment
2. RO water treatment system control panel specified under Section 232519.20 – Reverse Osmosis Water Treatment Equipment System Controls
3. RO water pumping system transfer pumps VFDs specified under Section 260515 – Variable-Frequency Motor Controllers and Section 232519.40 – Reverse Osmosis Water Pumping System
4. RO water pumping system control panel specified under Section 232519.40 – Reverse Osmosis Water Pumping System

F. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including monetary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

G. Equipment Evaluation Report: Prepare a report on the adequacy of protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties. Identify existing equipment that is overstressed with recommended solution, including series rating of the equipment if that is possible. If series ratings for protection of existing electrical equipment are approved by the Engineer,

provide caution labels for all series rated equipment for compliance with NEC 240.86 and 110.22(B) or (C).

1. Equipment evaluation report shall include all new electrical equipment and all existing power distribution system equipment located at the Farmington Correctional Center Power Plant that is in the series connected path from the new equipment to outdoor transformer "T1" and to the 200kW diesel-engine-driven generator at the Power Plant as indicated on Project Drawing E-601.

1.12 COORDINATION STUDY

A. The final approved settings shall incorporate the results of the Arc Flash Risk Assessment to minimize the hazard associated with the related systems.

B. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Electrical distribution system diagram showing the following:

   a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment

   b. Circuit-breaker and fuse-current ratings and types

   c. Transformer kilovolt amperes, primary and secondary voltages, connection types, impedance, and X/R ratios

   d. Cables: Indicate conduit material, sizes of conductors, conductor insulation, and length

   e. Motor horsepower and code letter designation according to NEMA MG 1

3. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram

   a. Special load considerations

   b. Magnetic inrush current overload capabilities of transformers

   c. Motor inrush current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve

   d. Time-current characteristic curves of devices indicated to be coordinated

   e. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers

   f. Switchgear, switchboard, panelboard, motor control center, motor starter, and variable-frequency motor controller interrupting ratings in amperes rms symmetrical

C. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

D. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

E. Comply with IEEE 141 and IEEE 242 time intervals.

F. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Self-cooled, full-load current for the transformer.

b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag

b. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings

c. Fuse-current rating and type

d. Ground-fault relay pickup and time-delay settings

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including existing upstream devices. Show the following specific information:

a. Device tag

b. Voltage and current ratio for curves

c. Three-phase and single-phase damage points for each transformer

d. No damage, melting, and clearing curves for fuses

e. Cable damage curves

f. Transformer inrush points

g. Maximum fault-current cutoff point

3. Study shall include a narrative identifying any potential coordination short falls and recommendations for change.

4. Completed data sheets for setting of overcurrent protective devices

1.13 OVERCURRENT PROTECTIVE DEVICE SETTINGS

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment.

B. Testing: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

a. Verify that overcurrent protective devices meet parameters used in studies.

b. Adjust devices to values listed in study results, if overcurrent protective devices are adjustable.

c. “Seal” each relay/adjustable circuit breaker setting access cover with an approved sealing device, Square D “TUSEAL” or approved equal, to prevent unauthorized changes to settings.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures", and Tables 10.7 and 10.8 in NETA “Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems”.

1.14 ARC FLASH RISK ASSESSMENT

A. Gather and tabulate the information provided by the Short Circuit Analysis and the Coordination Study, for the preparation of the Arc Flash Risk Assessment.

B. The intent of the Arc Flash Risk Assessment is to achieve the lowest possible hazard ratings for the associated equipment while still maintaining the code required level of electrical coordination for the system. The results of the risk assessment shall be incorporated into the recommended protective device settings to minimize the arc flash hazard.

C. Scope of Work:

1. Provide arc flash risk assessment warning labels in accordance with NEC Article 110-16 for the following equipment:

a. All new electrical equipment and all existing power distribution system equipment located at the Farmington Correctional Center Power Plant that is in the series connected path from the new equipment to outdoor transformer “T1” and to the 200kW diesel-engine-driven generator at the Power Plant as indicated on Project Drawing E-601.

D. Arc Flash Risk Assessment:

1. The Arc Flash Risk Assessment shall be performed with the aid of computer software intended for this purpose in order to calculate Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances.

2. The Arc Flash Risk Assessment shall be performed in conjunction with a short-circuit analysis and time-current coordination analysis.

3. Results of the Risk Assessment shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash

protection boundary distances, personal-protective equipment classes and AFIE levels.

4. The Risk Assessment shall be performed under worst-case arc flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

5. The Arc Flash Risk Assessment shall be performed by a professional engineer who is currently registered in the State of Missouri.

6. The Arc Flash Risk Assessment shall be performed in compliance with the latest edition of IEEE Standard 1584, the IEEE Guide for Performing Arc Flash Calculations including any and all addendums and errata.

7. The Arc Flash Risk Assessment shall include recommendations for reducing AFIE levels and enhancing worker safety.

8. Prior to final approval, incorporate actual installed cable/conductor lengths into the Arc Flash Risk Assessment.

E. Comply with NFPA 70, NFPA 70E, and NFPA 70B standards for the Study Report.

F. Field Labeling and Signage:

1. Provide complete arc flash hazard warning signage per NFPA 70 Article 110-16 at each switchgear, switchboard, panelboard, low-voltage distribution transformer, motor control center, enclosed switch (safety disconnect switch), motor starter, variable-frequency motor controller, and other equipment if/as required by National Electrical Code (NEC) and/or NFPA 70E requirements.

2. Arc flash hazard warning labels shall be provided in accordance with Section 260553 – Identification for Electrical Systems.

1.15 COORDINATION OF WORK

A. Adjustment of protective device equipment to meet the approved protective device coordination submittal shall be the responsibility of Division 26 at no additional cost to the Owner.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 260573

SECTION 260583 – WIRING CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all wiring connectors and terminations for 600-volt building wire, 600-volt multi-conductor control cable, and 600-volt shielded instrumentation cable as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 230515 – Variable-Frequency Motor Controllers

B. Section 260500 – Common Work Results for Electrical

C. Section 260519 – Low-Voltage Electrical Conductors and Cables

D. Section 260526 – Grounding and Bonding for Electrical Systems

E. Section 260533.16 – Boxes for Electrical Systems

F. Section 262816.16 – Enclosed Switches

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for each of the following items:

1. 600-volt connectors
2. 600-volt terminations
3. CAT 6 copper Ethernet connectors

PART 2 - PRODUCTS

2.1 600-VOLT CONNECTIONS AND TERMINATIONS

A. *Pressure Type Terminal and Splice Connectors:* Solderless, color coded, nylon insulated, pressure type, UL Listed 105°C, 600-volt, sized for the cable to be terminated or spliced, tin-plated copper, with crimping tool coded to the connectors with stops to prevent over-crimping and means to prevent under-crimping; 3M Scotchlok or approved equal.

B. *Spring Type Splice Connectors:* Solderless, color coded, flame retardant polypropylene and thermoplastic elastomer or flame retardant nylon, spin-on wings, spring steel inner spring with corrosion resistant coating, UL Listed 105°C, 600-volt, sized for splicing two or more conductors up to size #6 AWG; 3M Performance Plus or approved equal.

C. *Control Wiring Connections and Termination*: Control wiring connectors shall be vinyl or nylon pre-insulated spade lugs to match stud or screw size with insulation grip sleeve flared to prevent turned-back strands and crimping tool to crimp wire barrel and insulation sleeve.

D. *Power Connections and Terminations:*

1. Size 12 AWG through 2/0 AWG connectors shall be non-insulated, one-hole rectangular tongue, for copper conductors, UL Listed 90°C, 600-volt.

2. Size 3/0 AWG and larger conductors shall be non-insulated, two-hole rectangular tongue with long barrel length to permit two (2) crimps for copper conductors, UL Listed 90°C, 600-volt.

3. In-line splices shall only be made where specifically indicated on the Drawings or where pre-approved by the Designer.

a. Size 12 AWG through 2/0 AWG connectors, for splicing like sized conductors, shall be non-insulated, standard length barrel, for copper conductors, UL Listed 90°C, 600-volt, compression type.

b. Size 3/0 AWG and larger connectors, for splicing like sized conductors, shall be non-insulated, long barrel length to permit two (2) crimps on each conductor, for copper conductors, UL Listed 90°C, 600-volt.

c. Size 12 AWG through 3/0 AWG connectors, for splicing different sized conductors, shall be Thomas & Betts C-Tap compression connections or approved equal. Overwrap connectors with a minimum of three (3) half-lapped layers of Thomas & Betts Shrink-Kon TBFT201-36 self-fusing insulation tape.

E. *Power Termination and In-Line Insulation:*

1. Insulating Putty: 3M Scotchfil electrical insulating putty or approved equal by Thomas & Betts

2. Insulating Tape: 3M Scotch 23 or Thomas & Betts Shrink-Kon TBF201-36 self-fusing insulating tape

3. Jacketing Tape: 3M Scotch 33+ jacketing tape

4. For in-line splices, provide pre-engineered cold shrink or heat shrink insulating kits by 3M, Raychem, or Thomas & Betts in lieu of tape insulation, when available.

2.2 CAT 6 COPPER ETHERNET CABLE CONNECTIONS

A. RJ-45, 8-pin compression type with locking tab meeting the requirements of ANSI/TIA-568-C.2 with snag-proof strain relief, field installable connector compatible with the cable onto which installed.

PART 3 - EXECUTION

3.1 GENERAL

A. Conductors shall be continuous from source to destination without splices or taps in conduit runs, except where indicated on the Drawings to compensate for voltage drop or where required to prevent excessive pulling tension or sidewall pressure on wire or cable. Submit all proposed splice locations to the Designer for approval prior to pulling wire and cable. Where permitted, splices shall be mechanically strong and have an insulation value equal

to the wire or cable being spliced. All splices and taps shall be contained within NEC sized junction boxes meeting the requirements of Section 260533.16 – Boxes for Electrical Systems.

3.2 CONTROL & INSTRUMENTATION WIRING CONNECTIONS & TERMINATIONS

A. Thoroughly clean wires before installing connectors.

B. Tape back spare conductors with the specified jacketing tape.

C. Where attachment is to a terminal block screw or stud, install using pre-insulated spade type connectors.

D. Where control cable terminations are split across terminal blocks or are otherwise separated by more than 12 inches distance, identify each conductor group with the circuit number as specified in Section 260553 – Identification for Electrical Systems.

E. Conductor to conductor splices shall be made using spring type splice connectors. No crimp type connectors shall be used for these types of splices.

1. Apply a minimum of three (3) half-lapped layers of jacketing tape over each and every spring type (wire nut) splice connection.

3.3 600-VOLT CONNECTIONS AND TERMINATIONS

A. Cut conductors to proper length such that the barrel or inner metal spring of the connector makes full contact with the bare conductor and not the insulation and the plastic skirt of the connector full covers the bare conductor.

1. Conductor to conductor splices for size 10 AWG or smaller conductors shall be made using wire nuts or wing nuts. No crimp type connectors shall be used for these types of splices.

2. Apply a minimum of three (3) half-lapped layers of jacketing tape over each and every spring type (wire nut) splice connection.

B. Power Connections and Terminations:

1. Cover all exposed live parts such as connectors, bolts, nuts, and bus bar with insulating material to equal or exceed insulation of the connected cable.

2. At equipment with cable leads such as motors, install compression type terminal connectors on equipment leads and power circuit leads, bolt together, and insulate with pre-engineered motor terminal kits or as specified herein.

3. At equipment with integral set screw or clamp type connectors such as terminal blocks and molded case circuit breakers, strip conductor insulation as required to clear contact surfaces, and torque connector in accordance with manufacturer's recommendations.

3.4 600-VOLT POWER TERMINATION AND IN-LINE SPLICE INSULATION

A. Insulate with pre-engineered cold shrink or heat shrink kits when available, or with a minimum of three (3) half-lapped layers of insulating tape covered with three (3) half-lapped layers of jacketing tape.

B. Provide electrical insulating putty to fill major irregularities and voids in termination prior to application of insulating tape.

C. Apply self-fusing insulating tape directly to the conductors or over the electrical insulation putty.

D. Apply jacketing tape over the insulating tape to provide an outer covering for the cable termination.

E. Splices made using spring type splice connectors shall be insulated with a minimum of three (3) half-lapped layers of jacketing tape specified.

3.5 CAT 6 COPPER ETHERNET CABLE TERMINATIONS

A. Utilize the connector manufacturer's recommended installation tool(s) for cutting, stripping, and crimping cable and inserting into the connector.

3.6 FIELD QUALITY CONTROL

A. General:

1. Testing shall be performed in the presence of Construction Representative. Contractor must provide 48 hours' notice prior to conducting tests.
2. Prepare a test report upon completion of testing activities. Report format shall include the following information:
    a. Summary of test results
    b. Test equipment summary (model number, accuracy, calibration date)
    c. Test personnel names and sign-offs
    d. Completed data sheets
    e. Test log and observations
    f. Certificate of Compliance

B. Torque test conductor connections and terminations to manufacturer's recommended values.

C. Provide testing for 600-volt wire and cable in accordance with Section 260519 – Low-Voltage Electrical Power Conductors and Cables in conjunction with the testing specified herein.

END OF SECTION 260583

SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all fuses as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 230515 – Variable-Frequency Motor Controllers

B. Section 260500 – Common Work Results for Electrical

C. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Each type of fuse
2. Each type of fuse reducer
3. Each type of solid copper neutral link (dummy fuse)

1.5 EXTRA MATERIALS

A. The Contractor shall provide and turn over to the Owner 10% spare fuses (minimum of 3) for each size and type of fuse used on this project, including control fuses.

PART 2 - PRODUCTS

2.1 250-VOLT AND 600-VOLT FUSES

A. Fuses and their applications shall meet all the requirements of NEMA, the National Electrical Code (NFPA 70) and OSHA Part 1910 Subpart S. Fuse sizes and types shall be as shown on the Drawings and in schedules. Fuses shall be properly coordinated and shall be verified by the Contractor for the final load served. All fuses shall be Underwriters' Laboratories (UL) approved and shall have standard NEC dimensions.

B. Fuses used on circuits up to 250 volts shall be dual element, time delay, current limiting and shall have a minimum short circuit interrupting capacity of 300,000 RMS symmetrical amperes, UL Class RK1, LPN-RK, 250V for sizes up to 600 amperes.

C. Fuses used on circuits above 250 volts up to 600 volts shall be 600V, dual element, time delay, current limiting and shall have a minimum short circuit interrupting capacity of 300,000 RMS symmetrical amperes, UL Class RK1 or Class J (as indicated on the Drawings or as required to fit existing equipment) for sizes up to 600 amperes.

D. Motor controllers shall be protected from short circuits by dual element, time delay, current limiting fuses to provide Type 2 protection. This level of protection shall allow no damage to the controller, under low and high-level fault conditions.

E. Control circuit fuses (less than 5 amps) and associated fuse holders shall be as shown on the Drawings.

F. Fuses shall be as manufactured by the Cooper Bussmann Manufacturing Division of Eaton or approved equal by Mersen or Littlefuse.

2.2 NEUTRAL LINKS

A. Solid copper link or slug of same dimensions as a standard UL Class R or UL Class J fuse in sizes from 1 amp through 600 amps with verbiage similar to "THIS IS NOT A FUSE", "NEUTRAL LINK", or "DUMMY FUSE" permanently engraved into the device such that it is visible when the device is installed in the fuse clips.

B. Neutral links shall be as manufactured by the Cooper Bussmann Manufacturing Division of Eaton or approved equal by Mersen or Littlefuse.

2.3 FUSE REDUCERS

A. Fuse reducers are to be installed on fuse ferrules or blades to permit application of smaller dimension fuses than those for which the fuse blocks or holders are designed only where indicated on the Drawings.

1. 250 volt for UL Class R applications and 600 volt for UL Class R or J applications, ferrule or blade type as required.
2. Short-circuit current rating (SCCR) shall match the rating of the fuses.
3. Shall maintain strong mechanical and electrical contact between the fuse reducer and the fuse clips and the fuse reducer and the fuse.
4. Materials of construction: Brass, bronze, copper
5. UL Listed and Labeled

B. Fuse reducers shall be as furnished by Mersen.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall not be shipped and/or delivered to the job site with the fuses installed in place.

B. Install fuses in fuse clips with fuse label, indicating fuse type, voltage, and ampere rating, facing out such that the information is visible for inspection without removing the fuse from the fuse clips.

C. Utilize fuse reducers only where specifically called for on the Drawings.

3.2 NEUTRAL LINKS

A. Install neutral links in the B-Phase fuse clips of all fusible disconnect switches, panelboard and switchboard fusible switch units, motor control center feeder and motor starter units,

variable-frequency motor controllers, and in all electrical equipment for 480V, 3-Phase, 3-Wire, Grounded B-Phase power systems for compliance with Article 240-22 of the NEC.

B. Install neutral links in fuse clips such that the verbiage engraved on the device that states that it is not a fuse is visible for inspection without removing the device from the fuse clips.

END OF SECTION 262813

SECTION 262816.16 – ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. This specification section applies to all disconnect safety switches provided by the reverse osmosis water treatment equipment supplier and/or the reverse osmosis water pumping system equipment supplier if the input line disconnect switch is not provided as an integral part of the variable-frequency drive (VFD) enclosures as allowed under Section 230515 – Variable-Frequency Motor Controllers.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260526 – Grounding and Bonding for Electrical Systems

C. Section 260553 – Identification for Electrical Systems

D. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

E. Section 260583 – Wiring Connections

F. Section 262813 – Fuses

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for each type and size of disconnect safety switch used and shall indicate the short circuit current rating of the switch when protected by Class RK1 fuses, Class J fuses and with no line side or upstream fuse.

PART 2 - PRODUCTS

2.1 DISCONNECT SAFETY SWITCHES

A. Each disconnect safety switch shall be heavy duty type, single-throw, fusible or non-fusible type as indicated on the Drawings, dual horsepower rated, dead front and front accessible, having a non-teasible positive quick-make, quick-break contact mechanism rated for the voltages indicated on the Drawings.

B. Fusible type disconnect switches shall be designed to allow insertion of UL Class J fuses only. Fuse sizes shall be as indicated on the Drawings.

C. All fusible disconnect switches size 200 amps and below shall be equipped with non-metallic fuse pullers.

D. The switch operating handle shall physically indicate the ON and OFF positions of the switch. The switch operating handle shall be able to accept a minimum of two padlocks

for padlocking the handle in the OFF position and shall have the capability of accepting at least one padlock for padlocking the handle in the ON position. Padlocking provisions for the handle shall be based on using padlocks having heavy duty industrial type shackles 3/8-inch thick. The switch operating handle shall be an integral part of the switching mechanism, providing permanent control of the contacts, and shall be attached to the box or enclosure base and not to the cover or door.

E. The cover or door shall be mechanically interlocked with the switch operating handle to prevent opening the cover or door when the switch is in the ON position. An interlock override device shall be provided to allow authorized personnel to release the interlock for inspection purposes when the switch is in the ON position.

F. All switch blades shall be fully visible in the OFF position with the enclosure door open.

G. The switch voltage and ampere rating and the number of poles for each disconnect switch shall be as indicated on the Drawings.

H. All disconnect safety switches shall have a minimum short circuit current rating (SCCR) of 14,000 RMS symmetrical amperes at 480 VAC with the line side or upstream fuses indicated on the Drawings. Do not order any disconnect switch until the required short-circuit current ratings for each switch have been determined in accordance with Section 260573 – Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment.

I. Terminal lugs shall be Underwriters' Laboratories (UL) listed as being suitable for copper or aluminum conductors and shall be equipped with solderless connectors, front removable. All current carrying parts shall be plated by electrolytic processes to resist corrosion and to promote cool operation.

J. Heavy duty switches shall have permanently attached arc suppressors, hinged or otherwise, attached to permit easy access to line-side lugs without removal of the arc suppressors.

K. Each disconnect safety switch shall be equipped with a grounding bar that is bonded to the switch enclosure for termination of all equipment grounding conductors entering or leaving enclosure.

L. An electrical interlock for wiring into the control circuit shall be provided on each disconnect safety switch where indicated on the Drawings or where required by the equipment manufacturer. The interlock shall have one or two normally open and one or two normally closed sets of contacts, as indicated on the Drawings, which shall be mechanically operated from the switch mechanism or operating handle, breaking the control circuit before the main switch blades break (open). The contacts shall be rated 120 volts AC/DC, 15 amperes continuous, 60 hertz.

M. Switch enclosures shall be NEMA Type 4 without knockouts for indoor wet areas.

N. Metallic enclosures shall be prime coated with a rust-inhibiting phosphate and finished in ANSI-61 light gray or ANSI-49 gray baked-on enamel paint.

O. All enclosures shall meet UL Standard 98, shall be UL listed and labeled, and shall meet the applicable requirements of Federal Specifications WS-865c and NEMA Specifications KS1-1983.

P. Safety switch approved manufacturers are:

1. Eaton Type DH Series
2. ABB-GE Type TH Series
3. Square D Type H Series

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide disconnect switches, where required by NFPA 70, where indicated on Drawings, and where required by equipment manufacturer, in a location convenient for maintenance on each switch and adjacent equipment.

B. Provide fused disconnect switches when required to maintain equipment manufacturer's warranty or UL listing.

C. Rigidly mount disconnect switches on structural steel members on the equipment skid.

D. Provide fuses of the proper size and type in all fusible disconnect switches.

E. Provide durable fuse identification label permanently attached to the inside of the door of each fusible disconnect switch indicating fuse type, size, current limiting ability and device(s) controlled.

F. Install fuses in fuse clips with fuse label, indicating fuse type, voltage and ampere rating, facing out.

3.2 IDENTIFICATION

A. Mounted on the outside surface of each disconnect safety switch door shall be a three-layer engraved laminated plastic nameplate meeting the requirements of Section 260553 – Identification for Electrical Systems.

END OF SECTION 262816.16